THURSDAY, NOVEMBER 5, 1914.

DAIRY CHEMISTRY AND DAIRY CONTROL.

Dairy Chemistry: A Practical Handbook for Dairy Chemists and others having Control of Dairies. By H. D. Richmond. Second edition, revised. Pp. xi+434. (London: Charles Griffin and Co., Ltd., 1914.) Price 15*s.* net.

THE first edition of this book has been out of print a good number of years now, and many inquiries must have been made for the new edition of "Richmond." This second edition will therefore be welcomed by a large section of those who are interested in dairying, for the information it gives is difficult to obtain elsewhere.

The main arrangement of the new edition is similar to what it was before, and it would not be easy to improve upon much of the subject-matter. In the first chapter, for example, there is a particularly clear account of the constituents of milk, and sufficient detail of the chemistry of the constituents is given to satisfy any inquirer. Following upon this chapter comes one which deals with the analysis of milk, and here are given in detail the various methods of determining the specific gravity and the formulæ for calculating the total solids, etc. The milk scale is also explained very fully. Attention may here be directed to the author's water oven, which appears to be admirably adapted to the drying of milk samples if a vacuum drying apparatus is not available.

The quantitative methods for the estimation of boric acid and of milk sugar are given, and also the gravimetric and volumetric methods for the estimation of fat. Additional matter in this chapter deals with the acidity of milk and the method employed for indirectly estimating the proteins by means of the aldehyde figure.

The analysis of sour milk is dealt with very fully and also the methods for the examination of milk powders, which are now coming on to the market in increasing quantities. The chapter on the variation in the composition of milk calls for no special remark, except that the paragraph upon the influence of feeding, etc., upon the composition of milk puts very clearly before the reader what is known upon the subject. Those paragraphs that deal with the composition of condensed milk and milk powders will be found very useful for reference. There is also a great deal of useful information contained in the chapter upon the chemical control of the dairy, and by means of it the chemist ought to have no difficulty in checking the milk as it comes into the dairy and ensuring that it leaves, whether as milk or some other product, in a pure, clean form.

The determination of the fat percentage of milk by centrifugal methods (Gerber and Leffman Beam) is gone into very fully, and much practical advice is given.

A dairy chemist must also be something of a bacteriologist, and there is a chapter devoted to this side of his work. The outline of the chief bacteria in connection with milk and the methods of making nutrient media will be found useful. In view of the fact that some authorities place considerable reliance on the reductase and fermentation tests, a little more detail of the manner in which these tests are made would have been helpful. Both these tests can be carried out rapidly, and once the operator has accustomed himself to them and taken due precautions, they serve to give many valuable indications of the cleanliness or contamination of the milk.

The chapter on butter is excellent, all the chief methods of analysis being given in detail. For comparative purposes a brief account of the manufacture of margarine would have been useful. There has not been much alteration in the chapter on cheese and other milk products, but Van Slykes' method for the estimation of products of ripening, which looks as though it would become a standard, is given. The last chapter deals with the calibration of apparatus, and if some of the juniors in every laboratory were set to calibrate the burettes, pipettes, etc., it would be an excellent training and would show how inaccurate much of the cheap glassware is.

GEOLOGICAL BOOKS FROM AMERICA.

(1) *Introductory Geology.* A text-book for Colleges. By T. C. Chamberlin and R. D. Salisbury. Pp. xi+708. (New York: Henry Holt and Co., 1914.) Price 2 dollars.

(2) *Engineering Geology.* By Prof. H. Ries and Prof. T. L. Watson. Pp. xxvi+672. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 17*s.* net.

(1) THIS is essentially an abridged edition of the "College Text-book of Geology," published five years ago, and is perhaps the most readable of the volumes contributed to geological literature by these two distinguished American teachers. In the process of concentration they have avoided a jejune presentation of their subject, the treatment being interesting throughout. A vivid sense of the out-of-doors aspect of geological study is given by a large number of fine illustrations of the operation of geological agencies in different parts of the world.

The first 300 pages are devoted to geological processes and materials. Here are described the

work of the atmosphere, of overground and underground waters, and of snow and ice, vulcanism, and the movements of the earth's crust, and the nature and arrangement of rock-types and rock-masses. The second part, of some 400 pages, deals with historical geology. This should be of great service to students, especially those outside America, by providing a generalised, but not too brief account of the stratigraphy of North America, a subject of which no very satisfactory digest has hitherto been available. A classification of geological time into five eras is adopted — archeozoic, proterozoic, paleozoic, mesozoic, and cenozoic—and the description of the first of these is preceded by a discussion of the origin and constitution of the earth on the Laplacian and planetesimal theories respectively.

This part of the book is illustrated by numerous maps, sections, and figures of fossils, most of which are good. But the eighteen full-page maps showing the outcrop, underground extent, and eroded areas of the several systems in America are so largely conjectural that it is a question whether a single geological map in colours showing the actual outcrops, as at present known, would not have been more suitable and useful in a book of this kind. Many of the sections, especially those taken from the publications of the U.S. Geological Survey, seem unnecessarily detailed, and have suffered by reduction: their educational value might have been greater if they had been redrawn in a more diagrammatic form.

The book is an admirable statement of physical and stratigraphical geology from the American point of view, and will doubtless be warmly welcomed and much used by students and general readers for many years to come.

(2) This volume is based upon the courses in geology which the authors have been giving, for some years past, to students of engineering. The scope of the work is wide, and its treatment fuller than in most books on the subject which have hitherto appeared.

Chapters dealing with the minerals of rocks, and with the occurrence and origin of the rocks themselves, are followed by one on tectonics and metamorphism, in which the importance of jointing, cleavage, folding, faulting, and other rock structures in engineering operations are fully dealt with. This is succeeded by a chapter on rock-weathering and the formation of soils. The next two deal with surface and underground waters, and here the geological principles underlying water-supply, drainage, the sinking of wells, the construction of reservoirs, etc., are thoroughly discussed. A short chapter on landslides follows, and then two on the action of waves and currents in seas and lakes, and its bearing upon coastal erosion and harbour construction. The origin and economic uses of glacial deposits are then described. The remaining chapters deal with specific materials of importance to the civil or mining engineer, such as building stone, lime, cement, plaster, clay, fuels, road foundations, and road metals; the last chapter, intended for the metal miner, consists of a short account of the general principles of ore-formation and of the geology of certain of the useful metals. This, from limits of space, is necessarily somewhat inadequate.

At the end of each chapter useful references are given to additional literature on the subject therein dealt with. The book is well illustrated, and there is a triple index referring to subjects, localities, and authors. It is undoubtedly a useful addition to what has already been written on engineering geology. It is eminently practical, and its very direct application to a great variety of engineering problems should commend it, not only to students, but also to engineers in actual practice.

C. G. C.

APPLIED ELECTRICITY.

(1) *Alternating Currents and Alternating Current Machinery*. By Prof. D. C. Jackson and Dr. J. P. Jackson. New edition, rewritten and enlarged. Pp. ix+968. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1913.) Price 23*s*. net.

(2) *The Elements of Electricity*. By Prof. Wirt Robinson. Second edition. Pp. xv+596. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 10*s*. 6*d*. net.

(1) IN its thirteen chapters, this work covers fairly thoroughly the ground suggested by its title; in most places the theoretical side is treated with at least sufficient detail, but the constructional side has also received a good share of attention. We should have liked a somewhat fuller discussion of the motor-converter, and think the time is also ripe for some mention of the Kapp and Scherbius phase advancers and of the Hunt Cascade motor. The first few chapters impressed us very favourably, and although we were somewhat disappointed with the later chapters, we consider the book a good one, which will be of service to advanced students.

From the very beginning, the authors use the complex quantity, but it is not until chapter v. that we get a full explanation of the method. This chapter is an excellent one, but should have come earlier. The numerical examples given (single-phase problems) show well the use of the

complex quantity, but are scarcely sufficiently difficult to bring out any advantages for it, as the actual working is exactly the same as would be done by an intelligent student who had never heard of the Steinmetz methods. In a later chapter on polyphase circuits, other examples occur in which algebraic processes have to be carried out before substituting numerical values. In these the advantages become more obvious.

The authors do not quite attain to the standard set in their preface of "avoiding the error of presenting unnecessary formulas." On the contrary, we feel that a formula has been inserted wherever the slightest excuse for it can be found, even when the same formula has been given several times already.

The facts of nature do not depend on a particular choice of units, or, indeed, upon the existence of any units at all. It is therefore quite superfluous to introduce units into the mathematical treatment of these facts. Why will all authors not let their symbols stand for the *thing* itself, instead of for the number of times it contains some particular unit? The length of a foot-rule remains the same whether we call it "one foot," "12 inches," 30·48 . . . centimetres, or 304·8 . . . millimetres. The symbol L can just as well represent the length itself as any of these numbers, and in this way we are freed from the necessity of continually stopping to name the units to be employed, and from the irritating repetition of numbers such as 10^8, $4\pi \div 10$, 60, 746, 33,000, and so forth, which have nothing whatever to do with the laws, but arise from some particular (and unfortunate, although customary) choice of units, and thus distract attention from the real point under discussion. In the book under review, pages and pages might have been saved in this way.

Taking the book as a whole, the explanations are not as clear and concise as they might be; indeed, we found it exceedingly difficult to follow some of them. Several hydraulic analogies are given, but we are very doubtful whether these are really helpful, because the laws of hydro-dynamics have to be strained to make them fit the electrical case, and not infrequently the student's knowledge of that subject is less than of electricity.

(2) Except that part v. goes rather more fully into the technical side than is customary in books with its title, this book covers the well-worn ground of elementary magnetism and electricity. It contains little that is original in matter or in method, and its mathematics is uneven.

Many of the statements given ought to have attached to them the qualifying conditions under which alone they are true. Parts of the book are painfully laboured over some small point, while others are extremely superficial and betray a lack of insight into the true inwardness of the matter discussed.

In our science we have many traditions and dogmas from which we must ultimately break loose, and the sooner this is recognised by the writers of elementary text-books the better it will be for our students. What was best half a century or more ago is not necessarily even good now. Consider the electrostatic and electromagnetic systems of definitions. In chapter 39 the absurdity of the dimensional relations which arise from these definitions is pointed out; but in the other chapters which form the real book, we still have the old Gauss system omitting μ and κ. Why not omit the electrostatic system altogether? The sum total of our loss would be a fund of examination questions and a source of confusion as to what is intended when one of our most prominent physicists tells us that the charge of an electron is so many "units." The dielectric constant (we object to our author's "dielectric capacity") of air or other material would then appear to be what it really is—a thing the value of which has to be determined by experiment like its density, elasticity, or any other property.

Ohm's law, electromotive-force, and potential difference are always stumbling blocks. We should not deliberately blind our students to more than one-half of the phenomena by telling them that the current must flow from high potential to low potential; that a current must be flowing if two parts of a conductor are at different potentials; that a current cannot flow unless there is a potential difference; and that the P.D. is equal to the product of the resistance and current. When restricted to the proper cases, all these statements are quite true; but not a single one of them is always true, and the first and last are not even true in the majority of instances. We have only to consider what takes place in the battery branch of a circuit; in a homopolar dynamo; in a copper ring while a magnet is being thrust symmetrically into it, or in an ordinary electric motor, to see how badly we treat our students when we saturate them with these ideas, which they must later unlearn if they continue the subject.

In this book we have "resistance" in chapter 24, "Ohm's law" in chapter 25, and "Joule's law" in chapter 35. Surely the essential thing about resistance is that it causes a generation of heat when a current flows, and these two laws are merely different ways of looking at the same physical fact. A true understanding of electromotive

force would at once show that this is the case, and that the ultimate result of both laws is that the property of a given conductor which we call its "resistance" is a constant under certain conditions.

Again, we greatly object to the common practice of dragging in Ohm's law in connection with the magnetic circuit. Since the reluctance of the iron parts is not independent of the flux, even the mathematical analogy is very imperfect. There is no *real* analogy at all, for in the magnetic case nothing flows, and there is no continual generation of heat while the flux exists. A comparison with Hooke's law about stress and strain would be much more sensible.

Bearing in mind that it is intended to be a beginners' book, and that much detail is therefore not to be expected in the more advanced and technical portions, these are really the best; indeed, the last two chapters give excellent summaries of the leading facts about the discharge of electricity through gases and about electrical oscillations. DAVID ROBERTSON.

OUR BOOKSHELF.

Lehrbuch der vergleichenden Mikroskopischen Anatomie der Wirbeltiere. Edited by Prof. Dr. A. Oppel. VII. Teil, *Sehorgan,* by Dr. V. Franz. Pp. x+417. Price 18 marks. VIII. Teil, *Die Hypophysis Cerebri,* by Dr. W. Stendell. Pp. x+168. (Jena: G. Fischer, 1913–14.) Price 8 marks.

WE have on former occasions expressed a high opinion of the "Comparative Microscopic Anatomy of Vertebrate Animals," now appearing under the editorship of Prof. Oppel. The parts here noticed (Nos. 7 and 8) deal with the eye and pituitary body, and maintain the high standard set by the earlier parts. In systematising our present knowledge of the various forms assumed by the eye in vertebrates, Dr. Franz has utilised more than 650 papers published in recent scientific journals, and in the light of his own researches grouped a multitude of facts together, so that his text and numerous illustrations form a consecutive treatise as well as a most valuable encyclopædia for reference. He describes the minute structure of each part of the eye in turn—the retina, vitreous body, pecten, choroid, ciliary body, etc., tracing the variations undergone by each throughout the ramifications of the kingdom of vertebrate animals. The opening chapter deals with the visual cells of amphioxus; the closing one with the structure of the eye of species in which the sense of sight has been impaired or lost from disuse.

Dr. Walter Stendell's monograph on the pituitary body is of particular value at the present time. Until some thirty years ago this apparently unimportant structure was regarded as merely an interesting morphological puzzle. Our estimate was suddenly changed in 1886, when Dr. Pierre Marie discovered that the remarkable disease he described under the name of acromegaly was accompanied by a pathological enlargement of the pituitary body. It was then realised that what was supposed to be merely a small vestigial organ had a direct power of regulating and influencing the growth of the body. Embryologists, morphologists, physiologists, and pathologists then concentrated their attention on it, and the results of their labours may be seen in Dr. Stendell's pages, particularly in his long bibliographical list. We are glad to note he gives due prominence to the pioneer researches of Sir Edward Schäfer and of Prof. P. T. Herring.

Thresholds of Science. Astronomy. By C. Flammarion. Pp. xi+191. (London: Constable and Co.) Price 2*s.* net.

THE name of the author provides a guarantee of the soundness of the principles and the accuracy of the details expounded in this elementary introduction to astronomy by the eminent French astronomer. The book is essentially one for young readers, and the subject-matter is presented in a manner both lucid and interesting. The numerous illustrations are good, and aptly illustrate the text.

Commencing with the physical conditions of the earth, its motion and the resulting phenomena are treated at length, special attention being paid to the functions of the sun. A survey of the heavens with the constellations follows, and our relation to the "fixed stars" is made plain. The members of the solar system are treated individually, and their relations to each other in the system are efficiently illustrated. While dealing with the moon M. Flammarion introduces an interesting feature in a revue of the various mythical "Journeys to the Moon." The book concludes with a brief discussion of comets, nebulæ, and star clusters.

Although, as we are told in a footnote, "M. Flammarion naturally uses French measures" throughout the book, and the equivalents of the kilogram and kilometre are given, it would probably have been better had our own system of units been employed. The exercise in mental arithmetic required to obtain an estimate of the magnitude involved is very liable to break the continuity of thought, especially among the class of readers for whom the book is intended.

Bacon's New Contour Wall Map of Scotland. Scale, 1:316,800, or 5 miles to one inch. Size 48 by 60 in. (London: G. W. Bacon and Co., Ltd.) Price 16*s.*

THIS new edition of a well-known wall map will be welcomed in schools. It is drawn on a conical projection with true meridians of longitude and errorless parallels 55° 30′ and 58° north latitude. The main orographical features are shown in the familiar shades of green and brown, and sea depths in blue tints. The lettering is such that it does not interfere with the scheme of colouring, and the railways, which are shown in red, are easily followed. The map can be obtained mounted and varnished with rollers to hang on the wall, or mounted with eyelets and cut to fold.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Faraday's Views on Catalysis.

At the present time much attention is being given, both by chemists and by physiologists, to the mechanism of catalysis in heterogeneous systems. The interest of the question to physiologists is in connection with the mode of action of those catalysts produced by living organisms; these are called, for convenience, "enzymes."

The extraordinary insight shown by Faraday into the nature of the various phenomena with which he had to deal is well known and needs no further comment. But, on this ground, the paper which he published in the Philosophical Transactions of the Royal Society for the year 1834, entitled "On the Power of Metals and other Solids to Induce the Combination of Gaseous Bodies," deserves more consideration by modern investigators than it usually receives. The paper is also to be found in "Experimental Researches in Electricity" (vol. i., pp. 165–94), and the references given to quotations below refer to the numbered paragraphs in that reprint.

Although Faraday's work was published before the introduction by Berzelius of the name "catalysis," the combination of oxygen and hydrogen gases brought about under the influence of platinum and other solids, which is the subject of the paper before us, is clearly a case of this kind. In fact, the action of spongy platinum is given by Berzelius himself in illustration of the phenomenon.

The chief experimental fact of importance to the theory of the process, and demonstrated by Faraday in a number of different ways, is that the only condition necessary is the *perfect cleanliness of the surface* of the platinum (617). He points out that impurities of various kinds are readily condensed on the surface ("adsorbed," as we should say), from the air and even from ordinary distilled water. The presence of such films prevents that condensation of the gases which is requisite for their combination. In whatever way—mechanical, as by rubbing with polishing powders (591, 592, 593); chemical, by treatment with concentrated mineral acids (600); or by heat (596)—these substances are removed, the platinum is made active. Of special interest is the fact that making it either anode or kathode in dilute sulphuric acid (588) is particularly effective, the formation of "nascent" oxygen on the surface in the former case being the more powerful, as would be expected. The difference between the clean surface and the dirty surface is shown by the way in which water, or gases developed on the surface by electrolysis, enter into closer contact with the clean surface and form uniform films, instead of drops or bubbles.

It is pointed out in paragraph 617 that the intervention of electrical forces is excluded by the fact that both anode and kathode are active. Chemical reaction between the platinum and oxygen is also excluded by the fact that nitrous oxide and hydrogen are caused to combine (572). In paragraph 618 further evidence that the effect is not due to the intervention of platinum in a purely chemical way is given by the fact that "the effect is evidently produced by most, if not all, solid bodies."

The reader will probably call to mind that it has been held by some observers that this and similar activities shown by platinum are to be explained by the formation of intermediate compounds of the nature of oxides of platinum. The actual existence of such compounds has never been demonstrated, and the hypothesis did not commend itself to the acute mind of Faraday, whose explanation is of much interest. On account of the importance of the question I will quote the actual words used:—"They" (the phenomena under discussion) "are dependent upon the *natural conditions* of gaseous elasticity, combined with the exertion of that attractive force possessed by many bodies, especially those which are solid, in an eminent degree, and probably belonging to all; by which they are drawn into association more or less close, without at the same time undergoing chemical combination—and which occasionally leads, under very favourable circumstances, as in the present instance, to the combination of bodies simultaneously subjected to this attraction" (619). As we might put it now, gases are condensed on surfaces, losing thus the kinetic energy of their molecules, and, if capable of combining together, may be thus caused to do so. Could we have a clearer statement of adsorption and the part played by it in catalysis?

In further illustration of this "adsorption," Faraday proceeds to give some interesting examples of the condensation of water vapour and of air on the surface of various powders and on glass, pointing out in the latter case that there is no chemical affinity between air and glass. We note also that Faraday says that the vapour is condensed *upon* the substances. Again, "The gases are so far condensed as to be brought within the action of their mutual affinities at the existing temperature" (630), and "The platina is not considered as causing the combination of any particles with itself, but only associating them closely around it; and the compressed particles are as free to move from the platina, being replaced by other particles, as a portion of dense air upon the surface of the globe, or at the bottom of a deep mine, is free to move, by the slightest impulse, into the upper and rarer parts of the atmosphere" (631). As regards the adsorption of other substances on the platinum, we read: "In fact, the very power which causes the combination of oxygen and hydrogen is competent, under the usual casual exposure of platina, to condense extraneous matters upon its surface, which, soiling it, take away for the time its power of combining oxygen and hydrogen by preventing their contact with it" (632). We have here analogous phenomena in the action of enzymes, where an easily adsorbed substance, such as saponin, prevents the action of the enzyme by obtaining possession of the surface itself and thus excluding the condensation of the molecules between which chemical action is to be brought about.

Although Faraday evidently regards condensation on surfaces as especially applicable to gases, it is clear that he considers the phenomenon to be of general occurrence. He does not appear to have met with cases of adsorption of substances from solution in liquids, but he says "an analogy in condition exists between the parts of a body in solution and those of a body in the vaporous or gaseous state" (657). Is this statement to be looked upon as an anticipation of van 't Hoff's theory of solutions?

I will conclude my quotations from the paper with the following, which is worth bearing in mind at the present day:—"I am convinced that the superficial actions of matter, whether between two bodies, or of one piece of the same body, and the actions of particles not directly or strongly in combination, are becoming daily more and more important to our theories of chemical as well as mechanical philosophy. In all ordinary cases of combustion it is evident that an action of the kind considered, occurring upon the surface of the carbon in the fire, and also in the bright

part of a flame, must have great influence over the combinations there taking place" (656). The last sentence is interesting in connection with the work of Prof. Bone on surface combustion.

It is, perhaps, rather to be wondered at, since Faraday had gone so far in the interpretation of the phenomena, that he did not take the further step and bring them into relation with surface tension, to which Thomas Young had already directed attention.

In the application of these facts to the theory of enzyme action, the view was first definitely put forward by myself, so far as I know, in a paper in the *Biochemical Journal*, vol. i. (1906), pp. 222–27, that the "combination" between an enzyme and its substrate is of the nature of an adsorption. This view has received more and more support from work done by various investigators since that time. To mention one fact only, it has been found in the cases of several different enzymes that their activity is exercised in liquids in which they are completely insoluble, so that it must be the surface of the particles which is concerned. We know also that, in water, enzymes in general are in the colloidal state, a state in which chemical reactions obey laws which interfere with that of mass action in its simple form.

It is very doubtful whether intermediate compounds of a chemical nature play any part in catalysis by enzymes. None, at all events, have been shown to exist. Moreover, such an explanation is of very rare application to catalysis of any kind. The hypothesis of the action of enzymes which is most in agreement with all the facts known at present may be stated somewhat as follows: the molecules which are to enter into reaction are condensed by adsorption on the surface of the colloidal particles of the enzyme and their final state of equilibrium is brought about at a greatly accelerated rate. Whether, as Faraday seems to hold, the close approximation, and high concentration, is in itself sufficient to account, by mass action, for the increased rate of reaction is a matter for future investigation. It may well be, as Hardy points out (Proc. Roy. Soc., vol. lxxxviii. B, pp. 174 and 175), that it is in the actual process of condensation itself that the molecules are subject to stresses which result in exceptional chemical activity; their chemical potential may very well be raised in the process. It appears to be a phenomenon of very general occurrence that it is in the very act of change of state that special activities are manifested. This is particularly obvious in living organisms, where a system in equilibrium is dead, but it applies also to non-vital systems.

I would finally point out that it should not be stated that the action of enzymes does not obey mass action. Mass action is universal in its application; but, in heterogeneous systems it is controlled by other factors, such as diffusion and surface adsorption, the latter factor playing the chief part in the velocity of reaction in micro-heterogeneous systems, such as those of colloids. The rate of the reaction is conditioned by the relative masses of the molecules condensed on the surface at any one moment of time. It will be seen that the difficulty of applying the law of mass action consists in the determination of the real active masses.

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Tidal Friction and Ice Ages.

A CAREFUL study of the conditions of land height during the earlier stages of the Quaternary glacial period seems to show that the earth was then less oblate, *i.e.* the north and south polar regions stood higher than now, to the extent of as much as 10,000 ft. in places, while the equatorial regions stood lower, by some 500 ft. The spreading of ice-sheets from these high lands may well have been the initial cause of the cooling which produced the Glacial epoch.

Going further back in geological time, we find, as is well known, a series of long periods of epeirogenetic movement alternating with long periods of marine transgression. The last great change seems to have been continuous from Carboniferous times, with a girdle of land round the equator high enough to be heavily glaciated, through Mesozoic times, with a marine transgression, to Pliocene times, when the high land emerged at the poles.

Qualitatively, at least, it seems possible to read the late Sir G. H. Darwin's theory of tidal friction into these changes. By that theory, owing to the differential attraction of the moon on the tidal protuberances, the rotational momentum of the earth is gradually decreasing. This decrease may manifest itself in two ways, either by an actual decrease in the rotational velocity, or by a decrease in oblateness, *i.e.* by a movement of matter towards the poles.

It is probable that the earth's crust has a certain tendency to slide on its nucleus, and since the effect of tidal friction is chiefly felt in the crust, while the bulk of the momentum must lie in the heavy nucleus, it follows that the effect of tidal friction must be to tend to slide the crust round the nucleus parallel with the equator. As the crust must vary both in thickness and in the closeness with which it is attached to the nucleus, this means a thrust against the deeper and more closely attached portions. The thrust would tend to force some of the crust poleward on either side from the equator, *i.e.* to decrease the equatorial bulge.

But the friction between crust and nucleus is very great, and must in time result in an appreciable decrease in the angular velocity of the latter. Probably the action takes place in alternating steps—periods of constant rotational velocity, combined with a gradual thrusting of the crust poleward from the equator, alternating with periods of stability of the crust and gradual decrease in the rotational velocity. The former are periods of earth movement, mountain forming, and disturbance, resulting in the gradual deepening of the ocean over the equator and emergence at the poles; the latter are associated with a slow retirement of the ocean towards the poles, resulting in marine transgressions in middle and higher latitudes.

I have been able to accumulate a great deal of evidence which supports the theory I have outlined above on the geological side. I am, however, not sufficiently a mathematician to be able to satisfy myself that the cause, tidal friction, is commensurable with the effects, and I am begging the publicity of your columns to ask if someone better situated will help me in that respect.

C. E. P. BROOKS.
"Homeleigh," 3 Roseleigh Avenue,
Highbury, N., October 10.

AT the Editor's request I contribute a few remarks on Mr. Brooks's letter. The suggestion that tidal friction might be a cause of changes in the distribution of land and water is not new. It will be found in a "Note" in NATURE of April 25, 1889 (vol. xxxix., p. 613), where it is attributed to M. A. Blytt; and that may not be its first appearance. The character of the changes is that indicated by Mr. Brooks, but the mechanism by which they are effected is a little different. The hypothesis of a crust riding more or less freely on a nucleus is unnecessary, and difficult to reconcile with well-established results. Again, the frictional stresses do not operate directly to cause a flow of material towards or away from the poles, but indirectly by diminishing the speed of rotation.

The mechanical process may be followed very easily

without any mathematics. The surface of the ocean, apart from waves and tides, is at any time a figure of equilibrium answering to the speed of rotation at the time, more oblate when the speed is greater, less oblate when it is slower. Let us imagine that the lithosphere also is at some time a figure of equilibrium answering to the speed of rotation at that time. If the speed remained constant, the lithosphere would retain this figure, and the matter within it would remain always in the same configuration without having to support any internal tangential stress. Now suppose that the speed of rotation gradually diminishes. The surface of the ocean will gradually become less and less oblate. The lithosphere also will gradually become less oblate, but not to such an extent as to make it a figure of equilibrium answering to the diminished speed of rotation, while the matter within it will get into a state of gradually increasing internal tangential stress. The effect on the distribution of land and water will be that the depth of the ocean will gradually diminish in lower latitudes and increase in higher latitudes, the latitudes of no change being 35° 16′ N. and S.

The internal tangential stress in the matter within the lithosphere may increase so much that it can no longer be supported. If this happens a series of local fractures will take place, continuing until the lithosphere is again adjusted much more nearly to a figure of equilibrium, which will be less oblate than the original figure. The effect on the distribution of land and water will be that the depth of the ocean will increase rather rapidly and spasmodically in lower latitudes and diminish in higher latitudes.

Accordingly the kind of geological change which the theory of tidal friction would lead us to expect is a sort of rhythmic sequence, involving long periods of comparative quiescence, marked by what Suess calls "positive movements of the strand," in the higher latitudes, and "negative movements" in the lower, alternating with comparatively short periods of greater activity, marked by rise of the land around the poles and subsidences in the equatorial regions. It is for geologists to say whether the facts known to them are consistent with this description or not. A. E. H. LOVE.

The Age of a Herring.

IN the issue of NATURE for September 17 Prof. D'Arcy Thompson states that he is unable to persuade himself of the validity of Dr. Hjort's conclusions based upon the methods of determining the age of herrings by a study of their scale-rings.

It is, of course, impossible to attempt to deal in a few words with all the evidence brought forward in favour of these methods in recent years by different biologists, and we must, with regard to the herring, refer to our published papers,[1] where arguments are given in favour of the primary assumption that the age of a herring may be determined by counting the rings seen on its scales. The facts supporting this assumption are briefly:—

(1) For young individuals (up to age of three years) the results of age determinations by means of the scale-rings correspond with the results obtained by plotting frequency curves for the length measurements of the individuals.

(2) Scale examination of small herrings continued with short intervals during all seasons showed that the formation of the so-called winter rings took place during the winter, while the formation of the so-called summer belts commenced in the spring and continued during the summer months. That the summer belt is small at the commencement of the formation in May, while it is large on the completion of the formation in the beginning of autumn, has been proved by observations carried on during four years. Regarding the older fish, it has been difficult to proceed in the same manner as for younger fish, as the frequency curves fail to give any hints as to the age groups represented in a sample, while, on the other hand, the fishing season for the old herrings does not extend over all seasons of the year. The following facts point to the correctness of the assumption that the conditions here are strictly homologous to the conditions as regards the younger fish.

(3) Among the Norwegian herrings a great many

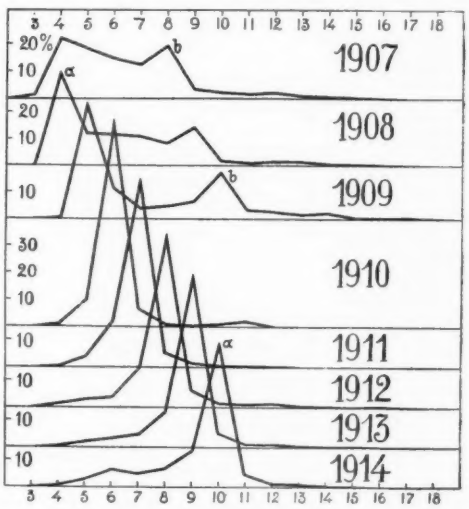

FIG. 1.—Showing the captures of Norwegian mature herrings for eight successive years, arranged in percentage frequency curves according to the number of rings on the scales (the numbers along the abscissa denoting the ring groups).

individuals had an abnormally small third summer belt on their scales. Herrings showing this abnormality have been very frequently observed during all the years from 1907 to 1914, but while the scales of these herrings in the year 1907 had only one summer belt outside the abnormal one in 1908, they showed two summer belts, and so on until the winter 1913–14, when they had seven summer belts outside. Thus these herrings, so easily distinguishable by their abnormality, have during the seven years of observation annually formed one summer belt on their scales, each belt being separated by a winter ring from the preceding and succeeding belts.

(4) By scale investigations on the Norwegian spring herrings (spawning herrings), carried out during the years from 1907 to 1914, results are obtained the main points of which are given in Fig. 1. This diagram is based upon all the material from 1907–13, while for 1914 part of the material was not worked up when the diagram was constructed (still the curve for this year is based upon more than 2000 individuals).

[1] Hjort, "Report on Herring Investigations until January, 1910," *Publ. de Circonst.*, No. 52. Copenhagen, 1910.
Hjort and Lea, "Some Results of the Internat. Herring Inv., 1907–11. *Publ. de Circonst.*, No. 61. Copenhagen, 1911.
Hjort, "Fluctuations in the Great Fisheries of Northern Europe," *Rapports et Procès-Verbaux*, vol. xx. Copenhagen, 1914.
Lea, "On the Methods used in the Herring Investigations," *Publ. de Circonst.*, No. 53. Copenhagen, 1910.
Lea, "A Study on the Growth of Herrings." *Publ. de Circonst.*, No. 61. Copenhagen, 1911.
Lea, "Further Studies concerning the Methods of calculating the Growth of Herrings," *Publ. de Circonst.*, No. 66. Copenhagen, 1913.

The diagram shows, for each year of observation, the percentage frequency of the individuals according to the number of rings on their scales, the figures along the abscissæ denoting the number of rings, while the corresponding ordinates denote the percentages of all the individuals falling in each ring group.

The most prominent feature of this diagram is the regular movement of the primary mode (*a*) from 1908–14, as well as of the secondary mode (*b*) from 1907–09.

While in 1908 the individuals having 4 rings were the most numerous, in 1909 those having 5 rings, in 1910 those having 6 rings, in 1911 those having 7 rings, in 1912 those having 8 rings, in 1913 those having 9 rings, and in 1914 those having 10 rings predominate.

In the same manner the secondary mode (*b*), appearing in 1907 by the relative numerical strength of group 8, moves one class to the right for each of the years 1908 and 1909.

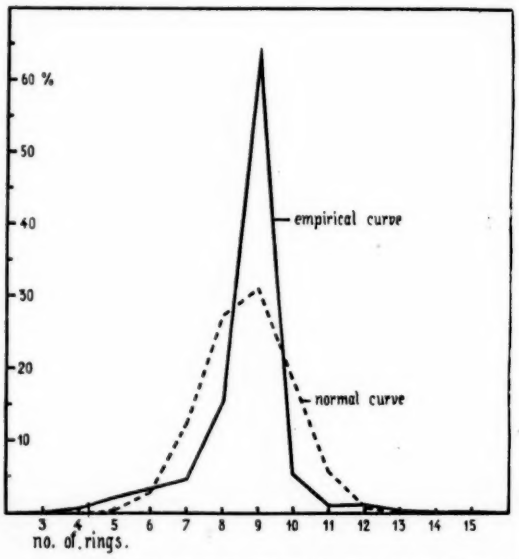

FIG. 2.—Comparison between the empirical ring curve for 1913 (in Fig. 1) and its corresponding normal variation curve.

It seems difficult to explain this regular movement of the modes, unless we assume that the two prominent modes represent two relatively abundant year-classes of herrings.

If this be true, then the material investigated leads to the conclusion that great fluctuations occur in the stock of Norwegian herrings with regard to the relative abundance of the different year-classes. That the magnitude of these fluctuations is astonishing and "very hard to imagine," is by no means an argument against the observed facts.

Prof. D'Arcy Thompson emphasises the regularity with which the so-called year-groups arrange themselves in a unimodal skew-curve, "just as the same fish group themselves also, according to size, in a unimodal but more normal curve." It seems to him "statistically improbable that a dozen separate generations of herrings, spawned in as many years, should have entered into the formation of the composite shoal in these curiously and regularly graded proportions." He finds it much easier to explain this fact by assuming that all the herrings (in a sample) were *of the same age and origin*, and that consequently the individual herrings vary about a certain modal number of rings, just as they also vary in a normal fashion about a certain modal size. He also emphasises the probability of an irregular age-curve for a population where large and irregular fluctuations occur in the annual birth-rate.

It might have been expected, then, that Prof. D'Arcy Thompson would have subjected the material published to a statistical analysis in order to convince himself of the correctness of his opinion regarding the similarity between the age-curves and the normal curves so usual in biology. He would then have found that no age-curve in the whole material of Norwegian herrings follows the usual law for biological variation. In some cases the age-curves present themselves by mere inspection as irregular (see Fig. 1, 1907, 1908, and 1909), while in other cases (when the curve is unimodal, as in Fig. 1, 1910–14) they are so entirely different from the normal frequency curve that it is totally impossible to replace the empirical curve by the corresponding theoretical one. This will be apparent from Fig. 2, giving the empirical age-curve for Norwegian herrings in 1913 (see Fig. 1) together with the normal curve for the same number of individuals, the same average and standard deviation, and the same arrangement of classes. In the following table the same data are given numerically:

Number of scale rings	Empirical frequencies in percentages	Theoretical frequencies in percentages	Difference empirical—theoretical values
3	0·1	0·0	0·1
4	0·7	0·0	0·7
5	2·2	0·4	1·8
6	3·4	3·0	0·4
7	4·8	12·5	− 7·7
8	15·4	27·4	− 12·0
9	64·7	31·2	33·5
10	5·2	18·5	− 13·3
11	1·2	5·8	− 4·6
12	1·3	0·9	0·4
13	0·5	0·1	0·4
14	0·2	0·0	0·2
15	0·2	0·0	0·2

The dissimilarity of the two curves is, in fact, so great as to exclude any idea of the age-curve following the usual law for biological variation. The feature that the curve is apparently unimodal, is due to the fact that one single group is so overwhelmingly abundant as to depress to a certain degree the irregularities actually existing in the frequencies of the other groups. By inspection of the age-curve for 1914 (see Fig. 1) it will be observed that the frequency of group 11, lying close to the modal group, is less than for the more extreme groups 6, 7, and 8.

For these reasons, as well as because of the regular movement of the modes, it seems to us impossible to explain the observed facts as a result of common variation, even if the help of a mathematical statistician were enlisted.

JOHAN HJORT.
EINAR LEA.

Scientific Work and the War.

DR. CALMAN'S plea (NATURE, October 22, p. 198) for the continuance as usual of the work of our learned societies, or even a wider plea for the calm prosecution of all our scientific studies, may be supported on many grounds, but the only one that I wish to emphasise is the moral effect thus produced upon those neutral nations whom our opponents seek to delude into the belief that we are panic-stricken. To the

reality of this effect the following sentences in a letter just received from a correspondent in Florence bear witness:—". . . e sapendo, d'altra parte, che l'Inghilterra sta fortemente sostenendo la sua bella lotta, senza perdere il tradizionale sangue freddo; per modo che la vita continua costà quasi inalterata. La regolarità, con la quale i periodici scientifici continuano ad apparire ne é la prova migliore." F. A. B.

THE CARE OF THE WOUNDED.

A FURTHER paper by Medical Inspector-General Delorme was read before the Paris Academy of Sciences on September 28, on the general subject of the treatment of wounds in war (*Comptes rendus de l'Académie des Sciences*, October 5, 1914).

The paper begins with a very welcome statement that the health of the French Army is excellent. "The persistent mildness of the weather since the war began, the extreme carefulness of the Government, the watchfulness of the Commands, from the lowest to the highest,—such fatherly watchfulness as you would not find, so intense and so alert, in any other campaign—the organisation and the regular methodical active working of the Army Medical Service, the great care given to the food-supply, the sites chosen for the troops—all these, up to now, have resulted in the maintenance of a perfect sanitary condition. The wounded Frenchman is a healthy man. Diseases are at a very low point. . . . Dysentery and typhoid are almost unknown: the proportion of cases has seemed to me to be even less than in time of peace." And, he adds, the spirit of the wounded men is perfect: it plays its great part in the work of a speedy and permanent recovery, "ce moral, qui est la traduction fidèle et tangible de la vitalité de l'homme." It is not the wounded who are broken-hearted: "le trouble n'est que dans le cœur des mères."

We are thankful to know that the general health of the French Army, and of our own Expeditionary Force, is thoroughly satisfactory. How long this blessing will last we do not know. But we may be quite certain that the Army Medical Services are working day and night for it, not in vain.

General Delorme's paper goes on to consider what more can be done for the wounded. He urges, very justly, that the large proportion of shrapnel-wounds and shell-wounds indicates the advisability of having a rather elaborate field-hospital system, as near the front as may be. Wounds of this kind, of course, are infected from the very moment of their occurrence: and it is a matter of the highest importance that they should be attended to, very thoroughly, at the earliest moment possible. The "first dressing" which may suffice for a cleaner wound, made by a bullet, will not suffice for them. The occasion may require the use of X-rays, the extraction of foreign bodies, the immediate administration of a protective serum or vaccine, and so forth: none of them to be delayed.

In the discussion of this communication the speakers were Laveran, Roux, and Landouzy; and the discussion was no less interesting than the paper. One, and that the worst, consequence of these infected wounds is, happily, under the control of a protective serum-treatment; and we may be sure that the money to provide that treatment will not be lacking. It is not simply a question of money: it is a question of what can be done, in this colossal fighting, to avoid loss of time in dealing thoroughly with so many infected wounds. As Landouzy says—and it is pleasant for an Englishman to read—"Il faut que, dans les armées des pays de Pasteur et de Lister, la Chirurgie active soit concentrée en partie et résolument vers l'avant, si l'on veut que l'asepsie et l'antisepsie des blessures de guerre soient possibles." STEPHEN PAGET.

THE TRANSIT OF MERCURY ON NOVEMBER 7, 1914.

MERCURY is one of the two planets which revolves round the sun in an orbit smaller than that of our earth, and consequently at a time of inferior conjunction generally passes just to the north or south of the sun. The reason why it does not always pass exactly between the sun and us is because its orbit is inclined at an angle of 7 degrees to the plane of the ecliptic, and the planet is only twice during a revolution at the cutting points or nodes, and is not necessarily at one of these points when passing on the near side of the sun.

When, however, conjunction does occur and the planet is near a node, it is seen to cross the sun as a small black spot, but it requires the use of a telescope to discern it. In May and November of each year the earth passes the nodal points, and it is only during these months that a transit can occur. On November 7 a very favourable transit will take place, and the whole phenomenon from start to finish will be visible from these islands during the interval comprising the two hours on each side of noon. Transits of Mercury are sufficiently rare to attract attention, as only about twelve occur in a century. The last one took place on November 12, 1907, and we shall have to wait until 1924, May 7, before another will be on view.

The planet makes first contact with the sun at 9h. 57m. 15s. on the morning of November 7 at a point on the sun's limb 156° from the north point of the sun counting towards the east. It takes the planet 2m. 14s. to place his whole disc completely on the sun. While it does not actually cross the centre of the solar disc, the time of its least distance from that centre is 12h. 3m. 22s. p.m. At 2h. 7m. 16s. p.m. the planet will have reached the sun's limb again, touching it at a point 255° from the north point, still reckoning in the same direction towards the east; it will take again 2m. 14s. to pass clear of the sun. It should be noted that the above times, although accurate enough for general observers, refer to the phenomenon as observed from the centre of the earth, and not as seen from the earth's surface.

Coming now to the method of making observations and the observations themselves, a word of warning should be given to those who are not familiar with making solar observations. No one should use a pair of binoculars or a telescope of any size unless proper precautions are taken; otherwise the loss of eyesight may be the result. It is better to make no attempt to watch the transit than to make risky observations. Proper dark glasses should be secured beforehand, and fixed firmly in position so that they cannot fall off at the critical time. A method devoid of all risk is to throw the solar image on a screen; in this way more than one observer can watch the transit.

In the *Comptes rendus* of the Paris Academy of Sciences for October 5 Monsieur Bigourdan summarises a series of the principal precautions which should be taken by those who wish to make useful observations. Such precautions are necessary because a transit of Mercury seems to be accompanied by various appearances the causes of which are not always well known. It is therefore advisable to eliminate so far as possible all possible errors which may arise through instrumental deficiencies.

He suggests first of all the method of observing the sun directly, and not by projection, for in the latter case delicate details are chiefly lost. To diminish the solar light he proposes a method of semi-silvering the outer surface of the objective, but he adds that this method holds good only when the sky is clear, otherwise observation would be impossible. The practical method of employing graduated and compensated dark glasses is chiefly recommended, and the greatest aperture of the telescope should be employed, having due regard to the heating at the focus, and the resulting cracking of the graduated glass.

While giving the preference to telescopes of large aperture, the results furnished by moderate or even small telescopes should not be neglected. Both reflectors and refractors should be brought into use. He directs attention to the importance of having diaphragms well blackened and suppressing for the time being any fixed accessories in telescopes which ordinarily serve for the illumination of the field, and which, situated in the path of the beam or in the vicinity of it would produce hurtful reflections. When an instrument can be reversed or can take up two positions successively to the right and left of its mounting, it should be utilised alternately in these positions, thus turning the whole optical system through 180°. Finally, he points out the importance of observing every appearance, however abnormal, by studying it in different positions of the telescope, with different eyepieces, dark glasses, etc. While the above precautions are particularly to be recommended for accurate observations, others of a secondary nature must not be forgotten.

With regard to the observations to be made during the planet's transit, those of first importance are the determinations of the accurate time of the internal and external contacts. Next come the measurements for the determination of the diameter and the flattening of the planet's disc. Rings (aureoles) around the black disc of Mercury form interesting objects for observation, and their intensity in relation to the neighbouring solar surface should be studied.

A spectroscopic survey of these rings would decide whether their existence was real or not, and the question of an atmosphere round Mercury could thus possibly be inquired into. Other points of interest relate to luminous appearances on the dark disc of the planet, possibility of satellites, occultations of solar spots, and faculæ by the disc, etc.

Successful observations of these and other phenomena help to further our knowledge of the movements and physical constitution of this the smallest of the planets.

A METEORITIC FALL IN LANCASHIRE

ON Tuesday evening, October 13, at 8.45, the inhabitants of Lancashire and Cheshire were alarmed by a sudden and vivid illumination of the heavens caused by a ball of fire moving slowly from about S.S.E. to N.N.W. It lit up the whole countryside and consisted of several outbursts, the final one being the brightest flash. Then a short interval afterwards, the estimated periods varying from a few seconds to four minutes, according to the distances of the observers, there was a tremendous report, as though a thunder-like explosion had occurred in the region a few miles west of Wigan.

This was followed by a series of rumblings extending apparently back along the flight of the luminous object. At several places the windows are stated to have been shaken, and the vibration was such that it presented some similarity to an earthquake shock.

Numbers of persons in Manchester, Liverpool, Halifax, Northwich, Bolton, Macclesfield, and other towns witnessed the event and heard the noise, and in the present agitated state of the public mind, all sorts of ideas were formed as to the nature of the phenomenon.

A large detonating meteor had, notwithstanding the rather cloudy state of the atmosphere, not only penetrated the lower region of the air, but had resisted complete disruption and fallen to the ground. It was discovered on the following day at Appley Bridge, four miles W.N.W. of Wigan. An employee of Mr. Lyon of Halliwell Farm noticed a newly turned up mound in a field and, on examination, he saw a reddish mass of strange material lying in a hole about 18 in. below the surface. On being dug out the object weighed about 33 lbs. and in appearance looked like a rough piece of burnt iron. Subsequently, the county police took possession of the strange visitor, and it has since been handed over to the curator of the Godlee Observatory, Manchester, for proper investigation.

My preliminary discussion of the first observations received indicated that the meteor penetrated to a point so low in the air that it probably fell in the region twenty miles west of Manchester. This conclusion was mentioned in a letter to the Manchester papers, and the discovery of the meteorite a few miles west of Wigan fully justified the prediction. Several of the observers say that the object lost its luminosity when still at an apparently considerable height. This appears to show that the motion had so far slackened that combustion had visibly ceased, and the object fell to the ground in an opaque, cooling condition. Evidence of this is also furnished by its penetrating the soil to a depth of only 18 in. Several well-observed meteoritic falls have been of merely terrestrial velocity amounting to 400 or 500 ft. a second, which is something different from the velocity of 26 miles a second possessed by these bodies in planetary space. The descent of objects of this class is often vertical or nearly so, and their original velocity and direction are apparently quite changed by the new conditions impressed on them during their disruption when very near the earth's surface.

I have collected a large number of observations of the flight of the object, from which it appears that its direction was from about azimuth 335°, counted west from south, or from S.S.E. to N.N.W., and the probable radiant was at 348° + 2° in the western region of Pisces. The course of the meteor was from near Stoke to the place of its fall, a length of 49 miles traversed at a velocity of about 8 miles a second. The height declined from 29 miles to 0.

The object is said to have made a slanting hole in the ground, and this would accord with an angle of some 37°, which a radiant at 348° + 2° would indicate. But the angle of the meteor's descent must have probably become much steeper after its entry into our atmosphere as an effect of the resistance encountered and terrestrial attraction. Several disruptions of its material undoubtedly occurred before the final outburst; these reduced the size and varied the shape of the object and may well have influenced the line of flight.

The radiant in Pisces yields many fireballs in September, and one was seen by many observers on September 8 last. Daniel's comet of 1907 has an orbit which approaches near the earth's orbit on September 12 and may possibly be responsible for some of the large meteors observed in September and at a later period.

Previous meteoric falls have occurred as follows in England, and I give the last recorded case in Ireland :—

1795	December 13, Wold Cottage, 56 lbs.
1830	February 15, Launton.
1835	August 4, Aldsworth.
1876	April 20, Rowton, 7¾ lbs.
1881	March 14, Middlesbrough, 3½ lbs.
1902	September 13, Crumlin, Ireland, 9½ lbs.

W. F. DENNING.

NOTES.

A COURSE of twelve Swiney lectures on geology will begin on Saturday, November 14, in the lecture theatre of the Victoria and Albert Museum, South Kensington, by Dr. J. D. Falconer, who will take as his subject, "Land Forms and Landscapes." There will be no charge for admission to the course.

M. BOUTROUX, member of the Institute of France, and professor in the University of Paris, has accepted an invitation of the British Academy to deliver the first of the recently endowed annual philosophical lectures. His subject will be "Certitude et Verité," and the lecture will probably be delivered early in December next.

ANNOUNCEMENT is made that the Serbian Government is in immediate need of the services of qualified bacteriologists and physicians experienced in the treatment of epidemic diseases. Conditions of service and remuneration will be made by arrangement. Applicants should communicate with the Secretary of the Serbian Legation, 195 Queen's Gate, London, S.W.

A SHARP earthquake was felt over the whole of northern Italy at 10.20 a.m. (9.20 Greenwich mean time) on October 27. The scanty reports which have appeared in the newspapers show that it was sensible from Venice to Elba, and from Turin to Ancona—that is, over an area of not less than 70,000 square miles. The epicentre was apparently near Lucca, or between that city and Bologna.

COL. W. B. BRYAN, who, as chief engineer of the Metropolitan Water Board, had much to do with the improvement of the London water supply, died suddenly on October 27. Col. Bryan was to have delivered the Thomas Hawksley lecture on "Pumping and other Machinery for Waterworks and Drainage," before the Institution of Mechanical Engineers on Friday last, but the lecture has now been cancelled.

DR. F. B. POWER will retire from the directorship of the Wellcome Chemical Research Laboratories on December 1, in order to return to the United States of America. His period of service dates from the foundation of these laboratories by Mr. H. S. Wellcome in the spring of 1896. Dr. Power will be succeeded by Dr. F. L. Pyman. The character and policy of the Wellcome Chemical Research Laboratories will continue as in the past.

A REUTER message from Stockholm reports that the Swedish scientific institutions which have to award the Nobel prizes in December have decided, in view of the European situation, to postpone the distribution of the prizes for 1914 for literature, medicine, chemistry and physics until next year. It is now proposed to hold the formal presentation of the prizes every year in the month of June instead of on December 10, the anniversary of M. Nobel's death, when the awards will merely be announced.

A GENERAL discussion on the hardening of metals has been arranged by the Faraday Society, to be held on Monday, November 23, at the Chemical Society, Burlington House, London, W. The president, Sir

Robert Hadfield, will preside over the discussion, and among those who will take part therein are Prof. Ernest Cohen, of Utrecht, Dr. G. T. Beilby, Prof. J. O. Arnold, Prof. H. C. H. Carpenter, Dr. C. H. Desch, Prof. C. A. Edwards, Mr. H. L. Heathcote, Mr. J. C. W. Humfrey, Dr. T. M. Lowry, Mr. Andrew McCance, Dr. W. Rosenhain, and others.

THE Dorset Field Club will award in May next the "Cecil" medal and prize of 10*l.* for the best paper on radium: its present position, supply, and cost; with any recent discoveries on its curative effects. The competition is open to any person between the ages of seventeen and thirty-five on May 12, 1914, who either was born in Dorset or had on the date mentioned lived in the county for the preceding twelve months. Further particulars may be obtained from Mr. H. Pouncy, the *Chronicle* Office, Dorchester.

BY the will of Mr. W. Erasmus Darwin, eldest son of Charles Darwin, the Royal Society of London is bequeathed the sum of 1650*l.*; his nephew, Mr. C. Galton Darwin, receives the portraits of Charles Darwin by Lawrence and Ouless, as well as Darwin's medals, Royal Society's candlesticks, snuff-box, christening mug, autobiography, notebook on children, two early sketches of "The Origin of Species," two vols. of "Hooker's Correspondence," the family Bible, the old Dutch brass-bound box containing the family papers, large silver soup tureen, the counterpane worked with the coat-of-arms, the letters written home from the *Beagle*, and pictures and miniatures. The desire is expressed that these relics should always be kept in the family.

A RESEARCH prize of the value of 200*l.* has been placed by Sir Robert A. Hadfield, past president, at the disposal of the Iron and Steel Institute, to be awarded by the council for original research work on the different combinations of carbon in iron, steel, and alloys of iron with other elements. It is proposed that the prize shall be awarded at the annual meeting of the institute in May, 1916, for the best report presented before February 1, 1916. Sir Robert Hadfield is prepared to offer a second prize for the report next in merit to that which gains the first prize provided it is adjudged to be really meritorious. It is suggested that the work should be in continuation of, or based upon, the work of previous investigators. The object of the prize is to stimulate the study of carbides in iron and iron alloys generally, also with a view of discovering the best method of determining the forms and combinations in which carbon occurs in iron and steel. It is desirable to define the composition of these combinations more accurately and to ascertain whether other carbides exist which have hitherto not been identified. The study of the molecular constitution of the carbides will also fall within the range of the investigation. It is hoped that the results obtained will throw much light on the cause of hardness of steel, also on the nature and form of carbon combinations with iron and its alloys. Intending competitors should communicate, in the first place, with Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, 28 Victoria Street, London, S.W.

Science of October 16 contains a memorial notice of the late Dr. Theodore Nicholas Gill, who died in Washington on September 25, in his seventy-eighth year. Although originally a law-student, Gill at an early age directed his attention to zoology, and in the winter of 1857–58, an expedition to the West Indies for the purpose of collecting shells and other natural history objects afforded him an opportunity of turning his inclinations to practical account. This was succeeded by a visit to Newfoundland in 1859, and in the following year he signalised his special interest in ichthyology by the preparation of a report on the fishes of the northern boundary for the U.S. State Department. Of wider interest was his catalogue of the fishes of the eastern coast of North America from Greenland to Georgia, published in 1861, of which a revised issue appeared in 1873. This and other works laid the foundations of his revised classification of fishes, which has been taken up and elaborated by Dr. D. S. Jordan and other American ichthyologists, and, according to the notice in *Science*, has now been accepted by European students of ichthyology. It must not, however, be imagined that Gill's work was restricted to fishes; on the contrary, it was unusually wide, embracing such diverse subjects as West Indian molluscs, the classification of mammals, and zoogeography. In 1861 Gill was accorded the chair of zoology at the Columbian (George Washington) University, Washington, a position he held until 1910, when he became emeritus professor.

SIR ERNEST SHACKLETON left Buenos Ayres for South Georgia on October 27 to carry on his trans-Antarctic enterprise. In a message to the *Daily Chronicle* of October 29 he announced some changes in the plans of the expedition. Instead of the *Endurance* returning to South Georgia and Buenos Ayres, after landing the members of the expedition, as was originally intended, she will winter in the Antarctic. Sir Ernest stated that on arrival at South Georgia all the dogs will be landed on one of the small islands of the group and left ashore. The geologists of the staff will also remain at South Georgia. The *Endurance* will then proceed south to examine the pack-ice and see whether it is loose enough to go into without unnecessary delay. After an examination of the pack the *Endurance* will return to South Georgia to pick up the members of the expedition and the dogs. The *Endurance* will be coaled to her fullest capacity, and, proceeding south again, will push right into the pack, keeping as much eastward as possible, in the hope of meeting more open water than is probably to be found further westward. Sir Ernest hopes to winter the vessel in 77·30° S. latitude, and if this point is gained at a sufficiently early date the transcontinental journey may be started this season. Should the ice conditions be too unfavourable, the journey will not be begun until October of 1915. The Argentine Government has provided the expedition with a wireless receiver, with which it will be possible to receive communications and time signals while the expedition is in the Antarctic.

IN the September number of *Folk-Lore* Miss C. S. Burne continues her valuable studies of the geograph-

ical distribution of British folk-customs. In this paper she deals with the customs known as souling, clementing, and catterning, practised in parts of the western midlands in November. They exhibit an example of successive layers of imported custom superimposed on a foundation of indigenous custom. First come the ancient, almost prehistoric, autumnal celebrations of the Old and New Year, probably always combined with a Feast of the Dead. Then Christianity transforms the pagan feast into the festival of Hallowmass. Next we meet with that combination of newly introduced subsidiary cults with newly organised and specialised crafts, which marks the progress of civilisation in the Middle Ages. Thus St. Clement and St. Catherine come into local prominence. Finally comes the period of decay, when the theological changes of the sixteenth century shatter the religious side of the kindly old customs, while simultaneously the centralising despotism of succeeding centuries and a civilisation growing more and more complicated deprive these rites, once so important, of any real significance, and they dwindle away or are kept up only by the most conservative part of the population, the children, wherever their elders allow them to benefit by them.

IN *Ancient Egypt* (part iv.) Prof. Flinders Petrie concludes his instructive review of the analogies between the culture and beliefs of ancient Egypt and those of certain African tribes. Such analogies are indicated by royal functions, beliefs, and material products. Among the royal functions attention is directed to the widely spread African customs in connection with the priesthood of the chief, his removal before he attains old age, and the concealment of the fact of his death; in sister marriage; in the importance assigned to the royal placenta, the leopard skin, and the ox tail; and in the use of the saw-fish as an emblem. Among beliefs we find similar analogies in the conception of the mundane spirit world; animism; the ancestral spirit; the roads for the dead; the ideas about twins, animal or human; the ram-headed god; the bull god; totemism and animal clans; the sanctity of the sycamore and the fig-tree; the sacrifice of red cattle; and divination by objects thrown. Egyptian culture, again, is connected with that of other parts of the continent by its pottery, mud toys, wooden head-rests, the wooden hoe, double process spinning, the use of the flat ground-loom, mosquito-nets, harpoons, drag and hand nets, basket traps, ring snares, and the ornamentation of the head by means of a cone. Individually these analogies may be of slight importance, but their cumulative effect is considerable. These various transfers of culture seem to have taken place in at least three periods: under the twenty-fifth dynasty at Napata, in the sixth century B.C., and after the introduction of Christianity.

PART 3 of vol. vii. of the Journal of the College of Agriculture, Tohoku Imperial University, is devoted to a synopsis of the Japanese chrysopid Neuroptera, with descriptions of several new species, by Mr. H. Okamoto. In connection with this may be mentioned a catalogue of books on entomology, chiefly from the library of the late Mr. Herbert Druce, issued by Mr. F. Edwards, High Street, Marylebone, W.

LIFELIKE photographs of grey-lag geese and of a specimen of the greater courlan (*Aramus giganteus*) recently received at the London Zoological Gardens form some of the most striking features in the October issue of *Wild Life*. The reader should, however, not have been left in the dark as to the native home of the courlan, and the attention of the editor may be directed to the need of greater care in proof-reading, as exemplified by the repetition on p. 32 of the statement that the sand-lizard is a slow mover, and of the substitution of "specimens" for "species" in the middle of p. 34.

INVESTIGATIONS carried on by Mr W. E. Collinge with the view of ascertaining the nature and quantity of the food of nestling sparrows have shown that in fruit-growing districts one hundred of these birds will consume nearly 2000 insects, and in suburban neighbourhoods about one-third of that amount. That sparrows are far too numerous is fully admitted; but it is suggested that if their numbers were considerably reduced they might be included in the list of benefactors. This and other information on the subject will be found in the October issue of vol. xxi. of the Journal of the Board of Agriculture.

AN excellent piece of systematic work is formed by Mr. A. H. Howell's revision of the so-called American harvest-mice, constituting the genus Reithrodontomys, published by the Smithsonian Institution as No. 36 of the *North American Fauna*. These mice, of which no fewer than fifty-five distinguishable forms are recognised, are chiefly a North American type, although the group also ranges through Central America to the northern States of South America. In the main essentially field-mice, they are in most districts only moderately numerous, although in a few they make their appearance in large numbers. As a rule, they do little harm, feeding for the most part on plants of no value to man.

IN *Symons's Meteorological Magazine* for July last Mr. L. C. W. Bonacina asked readers who had been in India whether lightning casualties, notwithstanding the severity of tropical storms, are not much rarer there than with us. He pointed out that many persons agree that thunderstorms in England are much more dangerous than in India. In the issue for October a correspondent ("G. G.") states that in the course of his travels in various parts of India, during a period of several years, he had only known or heard of one case of death by lightning, although a few high buildings, notably near Delhi, and tall trees in mountain districts, had been struck. He therefore answers Mr. Bonacina's question in the affirmative, the reason given being that thunderstorms occur higher up in the air. He states that he has never seen lightning in India so near the earth as he has in England.

DURING this summer experiments have been made with Langley's original "aerodrome" of 1903, and have proved that this scientifically designed pioneer machine is capable of flight with precisely its

original propulsive plant, wings, and rudders, and with 40 per cent. extra aggregate weight due to floats and their attachments. An account of these experiments is given in the *Scientific American* for October 10.

MESSRS. G. MICHAUD and F. Tristan, writing in the *Scientific American*, describe photographs and observations on the absorbing power of different flowers for invisible light. They find that the majority of flowers come out dark when photographed in ultra-violet light, but that a certain number of yellow flowers reflect the ultra-violet rays in a marked degree. In the case of the Compositæ this property is only exhibited by the exterior corollas. On the other hand, most flowers of any colour appear to reflect infra-red light to an equal degree.

IN the *South African Journal of Science* for September (vol. x., 14) Mr. Pedro Luis de Bellegarde da Silva advocates the use of wireless telegraphy in connection with the surveying operations now in progress in the province of Mozambique. At present these operations involve considerable delay owing to the peculiar nature of the country, and it is suggested that a distributing station at some place, such as Lourenço Marques together with small portable wireless outfits would enable the survey to determine the longitudes of many points in the province with greater expedition and accuracy than is possible with the present use of chronometers.

"THE Propagation of Disturbances in Dispersive Media" forms the title of No. 17 of the "Cambridge Tracts in Mathematics and Mathematical Physics," by T. H. Havelock (Cambridge University Press, 1914; pp. viii+87; price 3*s*. 6*d*. net). In it the author applies Fourier analysis to investigate the changes of form of a disturbance propagated in a medium in which the wave velocity is a given function of the wave-length. The theory of groups of waves of the most general type is thus discussed, and applications to optical problems are considered.

PART 213 of the Proceedings of the American Philosophical Society contains a paper by Prof. A. E. Kennelly and Mr. H. S. Sanborn, read before the society on April 24, which gives the results of a research carried out at Harvard University in 1911 on the effect of air pressure on the heat carried away from a hot wire by an air current blowing across it. In the original experiments of Prof. Kennelly and his pupils in 1909 it was shown that the watts which had to be spent in the wire to keep its temperature constant (400° or 500° C.) when air blew across it at a speed v between 200 and 2000 cm. per sec. varied as $\sqrt{v}$, but at lower speeds as $\sqrt{v}+30$. As Boussinesq in 1901 showed that the heat loss should also vary as the square root of the density of the fluid used, the present observations were made in a tank at various pressures, and it was found that for pressures above atmospheric the law held, but at lower pressures the power of the density was more nearly 0·4. They conclude that the constant of their heated wire wind velocity measurer or anemometer requires to be corrected for both temperature and pressure of the air. The effect of moisture in the air appears, however, to be small.

FOR many years there has been periodical agitation for the construction throughout the country of large granaries in order that there might be no possibility of a famine in the event of war. So far as the war has gone, the pressure of the Navy has shown that those who contended in favour of absolute ensurance of the command of the sea, in preference to such tentative measures, were right. Nevertheless, the immense granaries, which are increasing in number at our great shipping ports, are welcome on account of the facilities they afford for the discharge and distribution of grain, and for ensuring an adequate supply at the outset of war. The latest of these granaries, built by the Clyde Navigation Trustees at Glasgow, is described in *Engineering* for October 30. This granary has a total length of 312 ft., a width inside of 72 ft., and a total storage capacity for 31,000 tons of grain. While not so large as corresponding arrangements in Canada and the United States, the structural details of the Glasgow granary and the design of its machinery for discharging grain from ships and distributing it into and out of silos, are thoroughly representative of the best practice of the day, and of great and prolonged experience.

A LIST of the titles of English, American, French, and German medical and other scientific periodicals, together with prices of subscription, including postage to any part of the world, has been issued by Mr. H. K. Lewis, 136 Gower Street, London. Though only the leading publications are included, the list contains nearly 300 names. The periodicals published in Germany cannot be supplied during the war. The list will prove of particular service to librarians and of interest to medical men generally.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—M. Bigourdan communicates to the *Comptes rendus* for October 27 (vol. clix., No. 17) the substance of a telegram received from M. Comàs Solà, director of the Fabra Observatory, Barcelona, recording the discovery of a comet in a region of the sky recently occupied by Encke's comet. Its position on October 25 at 16h. mean Barcelona time is given approximately as R.A. 11h. 27m., and declination +50° 36′, and the movement is in a south-south-east direction at the rate of 5° a day. The comet is stated to be visible with a pair of opera-glasses.

THE COMET RECENTLY OBSERVED AT THE CAPE.—In this column on October 8 (p. 151) we recorded the appearance of a bright comet observed at the Royal Observatory, Cape Town, and published an ephemeris up to October 13, computed by Mr. Wood, of Johannesburg. The comet was stated to be fading, and at the same time to be rapidly decreasing its southern declination. This object has now been recorded from Barcelona, where it was photographed on October 17 last (*Comptes rendus*, vol. clix., No. 16, October 19). The note by M. Comàs Solà, presented by M. Bigourdan, to the French Academy, records its position as being R.A. 21h. 53m. 12*s*., declination −3° 14 at 8h. 9m., Barcelona mean time, the place

being determined from a photograph which showed the comet with a tail. Its direction of movement is given as north-north-west.

A LITTLE-KNOWN PIONEER OF SPECTRUM ANALYSIS.—While we owe the birth of spectrum analysis to Sir Isaac Newton (1642–1727), the first use of the slit to Wollaston (1802), and the first accurate mapping of the solar spectrum to Fraunhofer (1814), the name of the young pioneer, Thomas Melville, who followed closely after Newton is nearly forgotten. Although Melville died in 1753, at the age of twenty-seven, he was the first to employ the prism in laboratory research, for he undertook the examination of various flames, introducing sal ammoniac, potash, alum, etc., into burning spirits. He was undoubtedly the first to observe the yellow soda flame and notice its definite frequence in flames and its position as regards other colours. His name is briefly mentioned in Sir Henry Roscoe's "Spectrum Analysis," and Miss Clerke's "History of Astronomy," gives him full credit for his work. It was in reading the latter book that the attention of Mr. John A. Brashear was directed to the reference to Melville. Through Mr. Carnegie and Dr. Hew Morrison, the latter being principal librarian of Edinburgh, Mr. Brashear was enabled to obtain copies of Melville's essays read before the Medical Society of Edinburgh on January 3 and February 7, 1752, on observations on light and colours, in which appears the remarkable observation of the peculiar sodium light. These papers are now reprinted in the current number of the Journal of the Royal Astronomical Society of Canada (vol. viii., No. 4, July-August), and a very good service has been done by making them available to everybody.

DISPLACEMENT OF SPECTRUM LINES AT THE SUN'S LIMB.—Messrs. J. Evershed and T. Royds describe in Kodaikanal Observatory Bulletin, No. 39, some further researches they have been carrying on with regard to displacements of the spectrum lines at the sun's limb. Two explanations have been suggested to account for these shifts, one view being that they are due to pressure and the other due to motion in the line of sight. In this paper the authors state that the pressure theory presents a much more rational explanation of the phenomenon than the motion theory, but hold that there are difficulties in accepting the former, which have not been lessened, but largely increased by further research. The authors consider that the relative shifts of different lines at the limb have no particular meaning when determined by reference to lines at the centre of the disc, for these latter have shifts peculiar to themselves; the measures they have made show that the absolute shifts of the lines at the limb referred to a terrestrial standard show no relation to pressure shifts, and, further, the absolute shifts do not increase with the wave-length. In the investigation now published they determine the limb shifts by combining measures of limb minus centre shifts, with the centre minus arc shifts, the algebraical sum representing the absolute or limb minus arc shifts. They deal with the limb shifts in relation to the intensity of the lines, the relation between limb shifts and pressure shifts, limb shifts in relation to wave-length, and the shifts of the cyanogen bands. The conclusions they arrive at are that both the so-called cyanogen bands and the iron lines show shifts which they attribute to a movement of recession from the earth. While the view that the solar gases are actually repelled by the earth receives some support from other lines of evidence, they consider an alternative hypothesis, namely, that the sun's gravitational field affects the wave-length of the light emitted in accordance with Einstein's theory of relativity.

CLIMATOLOGY.

A PAPER by Dr. J. H. Garrett (Medical Officer of Health) on "The climate and topography of Cheltenham and its near neighbourhood" is published in the Proceedings of the Cotteswold Naturalists' Field Club for 1913 (vol. xviii., part ii.). The tables for thirty-five years (1878-1912) are derived from the records contained in annual health reports, or from the summarised values issued by the Meteorological Office. The figures show, as the author points out, that as regards the mean monthly maximum and minimum temperatures, the alternations from one season to another are very gradual. For the years 1892–1912 these were, respectively:—January, 43·6°, 33·6°; July, 71·6°, 53·4°; absolute maximum, 93° in September, 1911, minimum 6·5° in February, 1895. The annual rainfall shows considerable variation: 19·5 in. in 1892, 37·9 in. in 1882, normal for thirty-five years, 26·8 in. The prevalent wind directions are S.–W., those from N.–E. are comparatively few, while calms are very frequent. The average yearly sunshine (1903–12) was 1553 hours. Dr. Garrett remarks that quite a different climate is experienced on the Cotteswold Hills, within four miles of the centre of the town.

An elaborate discussion by Dr. V. Conrad of the climate of Carinthia, being part vi. of the valuable climatology of Austria, has been published by the Central Meteorological Institute of Vienna. This mountainous province covers an area of 10,327 km², of which 53·7 per cent. is above the level of 1000 metres. Like other Alpine countries it partakes of the sea climate of western Europe and of the land climate of eastern Europe, and is subject to abrupt contrasts within short distances. Tröpolach, for instance, in the Gail Valley, with an eastern aspect, has a mean January temperature of 18·7° F. and a winter temperature of 22·3°, while Pontafel, 7½ miles S.S.W., with a south exposure, has a January temperature of 28·6° and a winter temperature of 30·6°. The mean absolute yearly range of temperature in some of the valleys amounts to above 50° C. (90° F.); the absolute extremes recorded were below −22° F. and above 95° F. The yearly distribution of rainfall is well shown by a tinted map, referring to the period 1876–1900. With few exceptions there is a tendency towards increase of rainfall from north to south. The driest parts are the Noric Alps and neighbouring districts, with 31–35 inches of rain; the wettest parts are in the south-west, with 58–78 inches. The province possesses several long series of observations, *e.g.*, for Klagenfurt since 1813, but there is only one sunshine recorder, which is at the latter station.

Dr. Filippo Eredia has recently contributed to the *Rendiconti* of the Accademia dei Lincei (vol. xxiii.) two interesting memoirs on the distribution of cloud in Italy. The papers show the seasonal and annual distribution for 132 cities, and the orographic influence on the monthly mean values at a number of stations in the valley of the Po. In the latter region, on the Adriatic, central and lower Tyrrhenian, and Ionian slopes, winter is the season of most cloud. On the upper Tyrrhenian slope and on those near the Alps, spring is the cloudiest season. At Alpine regions and those under the direct influence of mountain systems there is generally least cloud in winter and in summer at other stations. The mean annual distribution and amplitude are shown by diagrams.

Another paper by Dr. Eredia, on the climate of Southern Italian Somaliland, is published by the Colonial Ministry of Rome as No. 14 of *Rapporti e Monografie coloniali*. The observations include *inter alia* those made by the Italian expeditions and at stations afterwards established, and are carefully

discussed under six separate elements. The climatological conditions are dominated by the N.E. monsoon (December–March) and the S.W. monsoon (June–September). The author points out that the temperature is very regular, there being only a difference of a few degrees between the means of the hottest and coldest months. The absolute maximum and minimum quoted during 1910–12 at six selected stations are 98·6° (in April) and 59° (in August), both recorded at Brava. The rainfall reaches its maximum values in April and November; the first rainy period is followed by falls of decreasing intensity and frequency in the coastal districts, and the second period by very scanty falls in the interior and extreme dryness on the coast. The largest yearly mean quoted is 30·1 in. (on fifty-two days) at Balad, and the smallest, 10·6 in. (on thirty-three days) at Giumbo. Generally speaking, rain falls in eight months on the coast and ten months in the inland districts.

The Bulletin of the Italian Royal Geographical Society for August contains a useful contribution to the climatology of Ethiopia by Dr. Eredia and Dr. De Castro. The results are chiefly based on observations made partly at Addis-Abeba and partly at Addis-Alem, from November, 1901, to June, 1911, excepting between July, 1904, and April, 1905, with instruments supplied by the Italian Meteorological Office. Monthly results for each year are given for temperature and rainfall, and in a less complete way for humidity and wind-direction. The mean annual temperature is 62·1°; highest mean monthly maximum, 80·1 (May); lowest mean minimum, 42·8° (December); absolute maximum, 100·4° (September); absolute minimum, 32·0° (December). The annual rainfall is 47·7 in., on 148 days. The authors' division and description of the seasons give a good general idea of the climate: winter (October–December), low temperature and scarcity of rain; spring (January and February), moderate temperature and relatively small rainfall; summer (March–June), high temperature and relatively large rainfall; autumn (July–September), moderate temperature and abundance of rain. The division of the year into seasons by the natives is essentially based on the occurrence of rainfall periods.

An article by Prof. Karl Dove, on the climate of German South-west Africa, was contributed to *Himmel und Erde* of December, 19, 1913. The protectorate extends from 17° to 29° S. latitude, but its position on the west side of the continent greatly modifies its climatological features, as compared with those on the eastern shore. Near the coast the cold water of the Benguella drift-current reduces the temperature considerably; but the inland parts owe their relatively low temperature to their great elevation above the sea. The annual range is very regular, and the approach of summer or winter has little interest for the inhabitants compared with the date, duration, and amount of rainfall. The heavier falls mostly occur between January and March; irrespective of small variations, Prof. Dove states that, with the exception of the extreme south, six- to seven-tenths of the year's rainfall may be referred to those three months. In large tracts of the western zone the annual fall does not exceed eight inches, and in some years little or no rain falls, not only in the coastal districts, but also in the interior of the country.

A very interesting and useful work on the climate, typhoons, and earthquakes of Formosa, with tables and diagrams, has recently been issued by the Government-General of that island. The meteorological service was organised in 1906 under an Imperial Japanese ordinance; observations are made at ordinary stations, lighthouses and rainfall stations, and the work is carried on almost entirely at Government expense. The central observatory at Taihoku receives and discusses all observations and also receives a number of telegrams and issues weather forecasts and storm-warnings for the whole island. The climate is subtropical, and may be divided into two seasons; the seven months April to October may be regarded as summer, and the five months November to March as winter. Throughout the island the mean monthly temperature rises to 68° F. in April; from June to September it ranges between 79° and 82°. The highest readings reach about 95°, and in rare cases exceed 98°. In winter the variations between the north and south of the island become more apparent; in February, the coolest month, the mean is about 58° in the north, and 68° in the south. The lowest readings in the north do not usually fall below 41°, and in the south not below 49·6°. In winter the N.E. monsoon brings rain to the northern parts, and in summer the S.W. monsoon and thunderstorms bring abundant rain to the south; the island, therefore, possesses two rainy seasons, each differing in time and place. Formosa lies in the highway of typhoons, and is often visited by those destructive storms; during seventeen years (1897–1913) thirty remarkable storms occurred during the months June to October. Earthquakes are also frequent; all the ordinary observing stations are supplied with seismographs, and shocks are recorded somewhere in the island about every day and a half. The most violent earthquakes are generally in the south-west, and occasionally cause disastrous damage.

ORNITHOLOGICAL NOTES.

THE eighth volume, comprising 533 pages of text, of the *Boletin do Museu Goeldi* (*Museu Paraense*) is devoted to a catalogue of the birds of Amazonia—Catalogo das Aves Amazonicas—by Dr. E. Snethlage. The author, who joined the staff of the museum at Para in 1905, commenced work on this catalogue very soon after his arrival, and devoted to it a large portion of his time during the following half-dozen years. Fortunately, the collection of bird-skins in the museum—some 10,000 in number—is sufficiently comprehensive to have enabled him to accomplish his task on a thoroughly scientific and first-hand basis. The result is a work which forms a worthy companion to Dr. Ridgway's "Birds of North and Middle America," albeit in an absolutely and relatively smaller compass. The author is, indeed, to be congratulated on the conciseness of the generic and specific diagnosis and the clearness of the "keys."

In connection with the above may be noticed the concluding portion of Mr. R. Dabbene's distributional list of Argentine birds, which appears in No. 6 of the first volume of the *Boletin de la Sociedad Physis*, Buenos Aires. The author recognises a total of 324 species. In Dr. Snethlage's catalogue the species are not numbered.

In an editorial article in the August issue of *Wild Life* it is stated that the Paris Committee of Economic Ornithology has been discussing a scheme for breeding white egrets in the marshes of Corsica, and also for rearing these and other birds with valuable plumage in Tunis. In the latter country the idea is that the Government should offer stock-birds on easy terms to the colonists, such birds to remain Government property, but the resulting offspring to belong to the breeders. The same issue contains two beautifully illustrated articles on Spanish heronries, where white egrets, night-herons, and other allied species breed in large colonies.

The July number of *The Emu* contains coloured illustrations of two species of parrots from Northern Queensland, severally representing genera unknown

to occur on the Australian mainland until last year. The first is a local race of Geoffroy's parrot (*Geoffroyus personatus* or *G. geoffroyi*) of Timor, and the second of the red-sided parrot (*Eclectus pectoralis*) of New Guinea. That such common and brilliantly coloured birds should have so long escaped detection in a country like Northern Queensland is very remarkable.

In an article on the ecological relations of bird-distribution, published in the July issue of *British Birds*, Mr. S. E. Brock remarks that while the composition of a country's avifauna is, in one sense, directly related to the present and former configuration of land-masses, the form of its dispersal within the area is immediately attributable to the environmental control. In other words, "the efficient causes of separation between bird-groups in this country are less geographical than ecological; the specific environment is the true 'faunal area.' The group of species attached to a specific habitat compose an association the units of which are primarily inter-related through the connecting link of a common environment."

As the result of a recent comprehensive inquiry, by the issue of circulars, Mr. H. G. Alexander is enabled to give, in the September issue of *British Birds*, a full account of the present status of the land-rail in the British Isles. Throughout the south and east of England, at least from Devonshire to Lincolnshire and inclusive of the south-east Midlands, this once abundant species no longer breeds regularly, although a few pairs nest annually in most counties. In South Wales, the West of England, the Midlands, and so far north as the Pennine Range and the Yorkshire moors, a general decrease in numbers, apparently of more recent date than that in the east and south, is now in progress; but in the Pennines and the districts west of the same no decided diminution is noticeable, landrails being still abundant throughout this area, except on the moors. Everywhere the birds are recorded as mainly frequenting grass or clover, and seldom cereals. Whether this was always the case, or whether they formerly nested in corn, has an important bearing on several of the theories which have been advanced to explain the diminution in the numbers of the species.

In the same issue is recorded the occurrence on May 6, 1914, of a pair of Rüppell's warbler (*Sylvia ruebpelli*) at Baldslow, Hastings. This is the first British record of this rare east European species.

To the Transactions of the New Zealand Institute for 1913 (vol. xlvi) Prof. W. B. Benham contributes an article on the nomenclature of New Zealand birds, based on the *Reference List* of Mathews and Iredale.

Another article in the same volume, by Mr. H. Hill, gives the fullest account hitherto published of the history of the early discoveries of moa-remains in New Zealand, together with a discussion as to their geological age, and the probable date of extermination of these giant birds. Contrary to the now generally accepted view that moas were killed off by the Maoris within the last few centuries, the author affirms that these birds lived during the late Pleistocene—the epoch of intense volcanic action in New Zealand—and that they all perished suddenly as the result of such seismic disturbances and the emission of poisonous vapours long previous to the advent of the Maoris, or any other race, in the islands. Basing his views solely on the result of observations on the east coast, Mr. Hill proceeds to observe that none of the numerous moa-remains found in caverns show any evidence of having been touched by men or dogs; and he considers that when the great seismic cataclysm occurred all the birds rushed to the upland caves for refuge—where they were in many cases imprisoned by the fall of pumice in front of the entrance—while others perished in the open, choked by clouds of ashes or by noisome vapours; the remains of these latter being subsequently carried down to the lowlands by floods. No reference, it may be added, is made to the comparatively fresh condition of moa-remains in many districts, or to their alleged association with Maori camping-places and camp-fires.

In an article on birds observed last spring during a yachting cruise amid the Scottish islands, published in the August number of the *Scottish Naturalist*, the Duchess of Bedford directs attention to the vast numbers of fulmars snared at that season by the natives of St. Kilda, who bring them in by boat-loads. Such a practice, remarks her Grace, seems short-sighted on the part of people who depend largely upon these birds for a living; but, nevertheless, the fulmars still maintain their numbers. On the "Stack," which was also visited, the number of gannets has been estimated by one observer at 8000, and by a second at 50,000; a revised estimate is between 5000 and 6000.

R. L.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE proceedings in Section G opened at Melbourne with a paper by Prof. Petavel on aviation research. The author described the results of recent experiments on the air resistance of various shaped bodies at different speeds, and also on the lifting power of planes of various shapes. This was followed by a paper on railways and motive power by Prof. Dalby, who showed a number of curves relating to the development and cost of working of British railways, and discussed briefly the relative advantages of steam and electric traction. Mr. Hedley Thomson followed with a paper on a transmission system suitable for heavy internal-combustion locomotives, in which he maintained that the difficulties of the internal-combustion locomotive were mainly due to the want of a suitable variable-speed control mechanism, and that these difficulties were overcome by the Thomas transmission gear, which he described. Curves were shown illustrating the high efficiency and other advantages to be obtained in this way. The internal-combustion locomotive is of special importance in Australia because of fuel and water difficulties. A paper was then read on the Canberra plan by Mr. W. B. Griffin, who was awarded the premium offered by the Commonwealth for the best town-planning scheme for the new Federal capital. The paper dealt with the principles underlying the design of such a town and their applications to the site at Canberra. The Government exhibited a number of elevations showing what Canberra will look like if and when the present scheme is carried through. The concluding paper on the first day was by Mr. Kirkpatrick, on the development of the Port of London.

On the second day Dr. Rosenhain read a paper on the behaviour of metals under strain, and showed a large number of photomicrographic slides illustrating the crystalline structure of metals under various conditions of strain and temperature. He showed that the various phenomena could be explained on Beilby's hypothesis of the amorphous phase in metals. Prof. Dalby then described an attachment for testing machines by means of which the stress-strain diagram is photographically recorded as the stress is applied. He also showed some photomicrographic slides of the structure of metals. A well-illustrated paper by Mr. Humphrey on the Humphrey pump was next read. The discussion showed that Australian engineers were fully alive to the importance of this pump for irrigation, but several speakers regretted the apparent de-

parture from its initial simplicity in order to meet special conditions. Prof. Coker read a paper on the stress distribution in short compression members. By means of a transparent specimen and polarised light, the peculiar stress distribution due to the compression plates being of different material from the specimen was illustrated. It was shown that approximately pure compression stress can be obtained if both are of the same material. Sir Oliver Lodge read a paper on the artificial electrification of the atmosphere, in which he dealt especially with the production of rain by the direct electrification of the clouds. The proposal was adversely criticised by Dr. Simpson, of the Indian Meteorological Department, and by Mr. Hunt, the Commonwealth Meteorologist. It was pointed out that clouds are very poor conductors, hence the difficulty of giving them an electric charge, and, moreover, that the clouds are often very highly charged, as shown by lightning discharges, and yet without causing rain.

The third day was devoted to a joint discussion with the Agricultural Section on irrigation, opened by Prof. Luiggi, of Rome, with a very interesting paper on irrigation works in Italy. The author showed that irrigation and ceaseless toil had transformed large areas of arid land into smiling gardens. He went very fully into the financial aspect of the question, showing that irrigation schemes require Government support, and are not suitable for private enterprise. He described the engineering features of several of the large schemes now being developed in Italy. A paper on somewhat similar lines, entitled "Irrigation in Victoria," was read by Mr. J. H. Dethridge. Papers were read by Mr. Ferrar on the fertility of lower Egypt, and some factors controlling the growth of cotton.

The Sydney meeting opened with the presidential address on stress distribution in materials. The president, Prof. E. G. Coker, discussed the various experimental methods, dealing especially with two, viz., the measurement of local temperature rise due to strain, and the application of polarised light to transparent test-pieces. Mr. A. B. Wade read a paper on irrigation in New South Wales, in which, after discussing the rainfall and physiography of the State, he described the irrigation schemes now in hand, especially that in the Murrumbidgee area. He also described the construction of the great Burrinjuck dam. Prof. Luiggi showed a large number of lantern slides illustrating the works carried out under his direction in Tripoli since the Italian occupation; these include lighthouses, harbours, waterworks, railways, etc. He emphasised the fertility of a great part of the country, and pointed out that it was a great grain producer in the days of the Roman Empire, and that with irrigation and development it should once more become a prosperous agricultural country. Mr. T. W. Keele discussed the Nile flood records between A.D. 641 and A.D. 1451, in which he claims to have found a periodicity of seventy-six years and suggests a connection with Halley's comet. Prof. Dalby described the new engineering laboratories of the City and Guilds (Engineering) College, which are at present nearing completion.

On the second day Mr. Bradfield read a paper on the new electric metropolitan railway, for which Sydney is seeking Parliamentary sanction. The scheme includes a bridge of 1600 ft. span across the harbour, and the total estimated cost of the whole scheme is 17,000,000*l*. A paper was read by Mr. Adams on the Australian ports in relation to modern shipping, in which the author discusses the great demands made on the port authorities by the increased length and draught of modern ships and the consequent outlay which neutralises to some extent the saving effected by the increased capacity of the ships. The new wharf arrangements at Sydney were described.

Dr. Rosenhain followed with a paper on the distribution of phosphorus in steel, in which, after describing a new reagent (ferric chloride with small quantities of copper and tin chlorides) for tinting the surface and thus revealing the want of uniformity in the distribution of the phosphorus, he showed a number of photomicrographic slides. Prof. Hudson Beare described tests which he had made on two petrol fire-engines, and also on the resistance offered to the flow of water by canvas fire hose.

On the last day of the meeting Prof. E. G. Coker read a paper on the temperature cycle in heat engines, describing a method of obtaining records of the temperature cycles in gas-engine cylinders by means of thermo-junctions operating an Einthoven galvanometer. Prof. Thornton followed with a paper on the lost pressure in gaseous explosions, in which he suggested that the difference between the calculated and measured maximum pressure may be due to the sudden effect of the forces of cohesion in converting translational into rotational energy at the moment of formation of the molecule. A second paper was read by Prof. Thornton on the limiting conditions for the safe use of electricity in coal mining, in which he discussed the danger of explosion from electric sparks under various conditions. Mr. Balsillie contributed a paper describing the system of radio-telegraphy with which his name is identified, and which has been adopted by the Australian Government, the chief features of which are that electrostatic coupling is employed between the oscillatory circuit and the aerial, and that a gap is employed with a very powerful air-blast, which, it is claimed, gives a unidirectional spark and consequent quenching after a semi-period. In a paper on the capacity of radio-telegraphic aerials, Prof. G. W. O. Howe described a method of calculating rapidly the capacity of any type of aerial.

Two reports were presented by research committees; that by the committee on stress distributions in engineering materials consists mainly of a review and bibliography of the experimental methods of investigating the subject, especially the application of polarised light to transparent test-pieces. A number of the committee are engaged on work which is not yet completed. A stock of 3 tons of standard steel has been obtained so that all members may work on the same material and thus enable their results to be correlated.

The report of the committee on gaseous explosions summarises previous reports and discusses the measurement of the temperature in gas-engine cylinders, especially the method employed by Profs. Callendar and Dalby at the City and Guilds (Engineering) College.

A joint discussion between Sections A and G on wireless telegraphy was held at Sydney. Sir Oliver Lodge, who opened the discussion, reviewed the various explanations put forward to account for the transmission of signals around the curvature of the earth, and the variations due to the alternation of light and darkness. Mr. Balsillie, the Commonwealth wireless expert, communicated some very striking observations; he had found that with a wave-length of 600 metres the ranges by day and night were 450 and 2000 miles respectively, and that by increasing the wave-length the day-range was increased while the night-range remained unchanged. Enormous variations in the day-range were produced by small changes in the wave-length, *e.g.* from 600 to 800 metres. The long range at night was obtained equally well over land or sea, which suggested that the waves travelled through the upper atmosphere and not in proximity

to the earth. Prof. Howe showed curves indicating in some cases a marked maximum in the strength of signals at midnight, and not, as one might expect, a uniform strength during the whole period of darkness. Dr. Eccles related some remarkable effects noted in the neighbourhood of Pago-Pago, a very lofty pinnacle of highly insulating lava with a wireless station on the summit. A ship near the island received distant signals better when the island was in a position to intercept the waves, as if the lava pinnacle deflected the waves and concentrated them on the ship.

MALARIA AND THE TRANSMISSION OF DISEASES.[1]

WHEN I received the distinguished honour of being invited by the committee of this school to deliver the biennial Huxley Lecture—an honour depending not only on the merits of the school itself, but on the names of some of the greatest leaders of the profession who have actually delivered the lecture in the past—I conceived it to be my first duty to select a theme which might be worthy of the occasion. In that fine book, the "Historical Account of the Charing Cross Hospital and Medical School," by Dr. William Hunter, the eminent dean of the school, it is shown that the founder of the hospital and the school, Dr. Benjamin Golding, had already recognised so long ago as 1821 the importance of the study of tropical medicine; and it was therefore impossible that the subject of my lecture of to-day should not lie in this field. But the field is large; and I should be losing myself in the sand of too great diffusion were I even to attempt a cursory survey of it. It was told, however—and gathered from the lectures of my predecessors—that what my audience most desire to hear would be, not remarks upon others' findings, but rather a succinct history of personal experiences, displayed from the widest point of view. I say this to excuse my somewhat personal choice of theme. The history will be a survey of the past; and, though wider for that reason, may be the more lacking in interest to some of you who perhaps have already heard much of these combats of a day already bygone. It is the narrative of a very humble foot-soldier, but one, alas! who is no longer employed by his country at the front. My subject will be malaria and the transmission of diseases.

First allow me to add a little wreath to the monument which the past lecturers have erected to the memory of the great Huxley—and I should like to place it upon a vacant spot. We all know Huxley as the St. Paul of evolution, the bulldog of Darwin (as he described himself), and the interpreter of Darwin's profoundities to the world; and we also know him as the patient and passionate investigator and the patient and dispassionate thinker regarding phenomena. But, in my opinion, he was still more—though not a higher thing—a philosopher. Like thousands of others, I have been fed and refreshed with those wonderful essays, which, when, as his biographer tells us, his hand grew heavy for dissections, he gave to the world in his latter days. To my mind he had all of the very first qualities required for true philosophy. The clarity of his style, which he possessed in common with Hobbes, Locke, and Hume and the great French philosophers, was itself a guarantee of the genuineness and completeness of his thought—so different from the obscurity and pretension of style which many philosophers from the days of Herakleitus onwards have employed to cover their emptiness. Secondly, his mind was fiercely critical in its search for truth, and he accepted nothing as fact which he himself had not endeavoured to probe into to the depths. Thirdly, no one has ever doubted that his aim was, not to astonish or to defeat or to persuade, so much as to reach the actual truth of every matter which he dealt with; and this serves to distinguish him from many of those who work in a field which is particularly open to pretence and even to charlatanry. We all trust Huxley. He may have been wrong for want of facts, but not for want of sincerity and effort. It is the fashion of one generation to decry the labours of the preceding generation; but as time advances this error is put right, and Huxley will be seen from the distance to soar more and more above the eminent writers of his own time.

I can imagine nothing that would have delighted him more than the bearing of recent advances in science on the medicine of the tropics. Indeed, this latest victory of science, achieved after his time, may be considered as a culminating point in the practical application of science to the needs of suffering humanity. The victory has been won, not only by medicine, but by medicine and zoology fighting side by side—by those two great branches of science in which he himself was so proficient. Let me now describe the details of the campaign.

It is curious that though the transmission of disease is a matter of such vast import to every one of us, it has received so little investigation in the past. Even up to the middle of last century, our inquiries had led us little further than what I call the subscience of the subject—that is, we distinguished, classified, and named our various bodily inflictions. We also did more; for we had ascertained empirically the physiological and therapeutical effect of many drugs—quinine, opium, mercury, iodide of potassium, ipecacuanha, and others; and also that great genius Jenner had discovered a wonderful fact which is at the basis of the theory of immunity, prevention, and cure. But the causes of disease and their mode of transference still remained hidden. At that epoch, however, and afterwards, Pasteur, Koch, Lister, Behring, and others created the science of bacteriology. But still, though the information thus obtained was of prime importance to the pathologist, the physician, and the surgeon, we still remained much in the dark regarding one important issue, namely, the exact path of transmission of many diseases from man to man. Bacteria are easily saprophytic, and may have many paths of transmission, and, I fear, that we are still very much in doubt as to the most important of these numerous routes. We thought, and are often still inclined to think, that the germs of disease come to us from any place where they may be scattered—that they have not precise routes and points of entry. This leads us to a very vague prophylaxis. We undertake all kinds of disinfections in order to destroy the enemy, wherever he may possibly lurk; and the consequence is that we often fail to check infection as certainly as we wish. It has been the great result of the inquiries which I will now proceed to describe that they have, as the French say, precised our knowledge upon this point in connection with many diseases, and have indeed led to the discovery of another and most wonderful route of infection which until recently was undreamed of by the profession and the public.

The armies of science, like those of nations, commence with small beginnings and advance in parallel columns. If one column is checked by insuperable difficulties, the others endeavour to outflank the point of resistance; and a victory is often won by this means in science as in war. (Excuse my military similes, which appear to be appropriate at this hour.) That column of science which conquered the domain of bacteriology was brought to a standstill for some time as regards the exact transmission of disease until the

[1] The Huxley Lecture. Delivered at Charing Cross Hospital on Monday, November 2, by Sir Ronald Ross, K.C.B., F.R.S.

parallel column attacking from quite a different direction circumvented the difficulty in this respect.

The story commences with the studies of those obscure and often despised workers who toiled in the domains of parasitology. Some of the largest parasites were known in antiquity; but the ancients possessed quite a wrong notion of their origin, which they attributed to spontaneous generation—that is, they thought the parasites originate *de novo* in the host. In the seventeenth century, however, Radi proved that this hypothesis does not hold for certain insects; and later Pallas argued that parasites originate *ab ovo*, like other animals—that is, that their eggs escape from one host and enter another host, thus leading directly to the presence of parasites in the latter. This history possibly still holds for certain parasites; but in 1790 Abildgaard showed by experiments that some parasites of fish live not only in those fish, but for a part of their existence in certain water-fowl; and this extraordinary law, which may be called after De Barry's term slightly changed, the law of metaxeny, was proved during the middle of last century by Eschricht, Steenstrup, and especially Küchenmeister, to apply to a large number of Platodes and Cestodes. Afterwards Leuckart, Melnikoff, and others extended the law to cover other species, including species of Nematodes. A most important case was that of the *Filaria medinensis*, the famous guinea worm of man, which was shown by Fedschenko in 1869, following a suggestion of Leuckart, to be in common with man and a water flea (Cyclops). All this constituted a discovery which was both remarkable in that it exhibited the wonderful devices of nature for propagating parasites from host to host, and was also of the highest importance to mankind (though few recognised this point at the time) because it showed us how many of our great diseases are likely to be acquired.

Let me dwell on this point for a moment. Parasites, accustomed as they are to dwell in the safe retreats of certain portions of their host's body, must be exposed to great dangers whenever they come to pass, as they must do from one individual host to another. Thus if this passage is effected merely by the egg, it is obvious that the eggs must be poured out in immense numbers to compensate for their immense destruction outside the body of the host; since it would always be probable that only a very minute proportion of the eggs would ever find their way again into fresh hosts of the proper species. In order to avoid these difficulties, nature, I presume through an infinite period of evolution, has enabled many parasites to acquire a more safe and certain route of entry—through other animals which are associated frequently with their first species of host. Thus, for instance, a parasite of dogs and cats develops also in the dog-louse, and is therefore not scattered broadcast from the dog and the cat over the surface of the earth, but is retained alive in close proximity to the bodies of those animals. Remember that nature is as solicitous for parasites as for the higher animals which contain them. She thinks no more of man than of the minute germ which infests him. From her open hand fall innumerable species, and she endows them all with equal powers of looking after themselves and their own interests. It is not in the interest of parasites to be wasted abroad. It is in their interest to be brought again as quickly as possible to the host in which evolution has formed them to live—and that is why this wonderful law of metaxeny holds good. It must be remembered, of course, that no species of parasite should be allowed to develop in excessive numbers in the same individual host, because this would result in the death of the latter, and therefore also of the former. The parasite must therefore find some means of transference at some stage in its life-history; and that route must be the most expeditious possible. This most expeditious route will often be, as I have said, through another species of animal connected in its habits with the original host.

Following upon the discovery of Fedschenko, Manson in 1877 showed that the embryos of another Filaria of man (*Filaria bancrofti*) develop in a species of mosquito, probably a Culex. The life-cycle of this parasite, up to the point to which he demonstrated it, was closely similar to that demonstrated by Fedschenko for *F. medinensis*; and Manson did not complete the story. Now, however, other important discoveries were made, which showed that animal parasites do not by any means belong only to the zoological groups of the Cestodes, Platodes, and Nematodes, but that many of them are unicellular. Thus Leuckart established the protozoal order of the Sporozoa; Lankester and others discovered Trypanosomes and Hæmogregarines; Davaine discovered Cercomonads, and Lösch discovered the group of parasitic Amœbæ. Lastly, in 1890, Laveran made the most important discovery that malaria is associated with a minute protozoal parasite of the blood; and his observations were followed by those of Danilewski and others, who showed that similar parasites are to be found in many animals. All this extended the catalogue of animal parasites over a vastly larger field than was known to the ancients; and the morphology and life-history of the parasites in the known hosts were elaborated by numbers of workers, who also succeeded gradually in connecting them with some of the most important diseases which inflict man and animals. Thus it was gradually shown that Amœbæ are the cause of one form of dysentery and abscess of the liver; that Trypanosomes cause the deadly nagana of domestic animals in Africa, and the equally deadly sleeping sickness of man, besides many other maladies of animals of numbers of species. Ankylostomes were proved to cause miner's anæmia, which also was shown to be prevalent through vast areas of the tropics, by no means only among miners. The Trematodes called Bilharzia were shown to produce a terrible form of cystitis in Egypt and elsewhere. *F. bancrofti* were proved to produce elephantiasis and a number of other maladies which are very common in the tropics. Simultaneously malaria was seen to be caused by at least three different species of the group discovered by Laveran.

At the same time, of course, as I have said, the habits of all these parasites in the hosts in which they had been found were being minutely examined. But up to the last decade of last century we still could form scarcely any definite idea as to how the protozoal parasites pass from one individual host to another. The law of metaxeny which had been proved to apply to many of the larger parasites had not been extended to the smaller ones. In 1889, however, Smith and Kilborne discovered a small parasite called Piroplasma in the blood of cattle suffering from Texas fever; and, more than that, showed that in some mysterious way the infection is carried from ox to ox by means of certain cattle ticks—though they did not demonstrate in any way that these parasites undergo a metaxynous stage of development in the ticks, and indeed failed to find them at all in these arthropods. In 1896 also Bruce made his famous discovery that the Trypanosomes of nagana are conveyed by certain tsetse-flies, but supposed that the carriage is a mechanical one. And there the matter rested until the solution of the malaria problem opened a new field.

We now turn to the subject of malaria. Economically, as well as medically, it is certainly the most important disease in the tropics, perhaps in the world.

It is found almost everywhere in hot climates, and even in most temperate climates during the summer. From statistics we find that as a broad general rule in malarious countries about one-third of the total population suffers from attacks every year, and also that about one-third of the admissions to hospital and attendances at dispensaries are due to malaria. But these figures are merely based upon records, and do not cover the enormous additional number of patients who remain untreated. Thus we know that the malaria-parasites or malarial enlargement of the spleen can be found in native children in malarious countries to an enormous extent, reaching 100 per cent. in very insalubrious spots. The case mortality is only about 0·5 per cent., but the prevalence of the disease is so extremely great that the total mortality caused by it makes an addition to the general mortality of anything up to 10 per mille, or even 15 per mille; and the malady complicates all other diseases in the tropics in a way which renders them more difficult to treat. In India alone it has been officially estimated that the total deaths from malaria average about 1,300,000 a year in ordinary years, and may reach a much higher figure during years of epidemic prevalence. Thus the total bill of annual mortality and sickness which King Malaria presents to the human race is something enormous.

Hence the development of the human race, especially in warm countries, has long demanded that we should ascertain exactly how this plague is propagated and should endeavour to find how best it may be prevented. It is remarkable that even more than five hundred years before Christ the ancients certainly were acquainted with one great law, namely, that malaria is connected with stagnant water, such as marshes; and there are good grounds for believing that Empedokles of Sicily actually delivered Selinus from malaria by draining its marshes or by turning two rivers into them. This knowledge seems to have been generally held since ancient times, though it must have been acquired quite empirically; but Varro and Columella, at about the time of the Christian era, actually suggested that the disease is in some way connected with insects which breed in marshes. In more modern times, however, malaria has been ascribed to noxious vapours given off by stagnant collections of water—the hypothesis evidently being that the poison is some kind of chemical one. I have mentioned that in 1880 Laveran discovered that the disease is due to certain protozoal parasites in the blood. When this fact was accepted ten years later, many observers at once rushed to the conclusion that these parasites have an extra corporeal existence in marsh water, and actually attempted to demonstrate this by producing infection in healthy persons by such water brought from malarious localities. The experiments of Agenore Zeri (1890) are to be particularly mentioned. He gave water from the Pontine marshes persistently to a number of persons orally or in spray, or by clyster—but entirely without result. At the same time many thought that the poison may lie, not only in stagnant water, but generally in the soil of warm countries—this being called the hypothesis of the telluric miasma; but, of course, this was merely a hypothesis which did not rest upon any observations or experiments. Even ten years after Laveran's discovery we were still completely ignorant as to how the malaria parasites enter the body. We might search for them in marshes and soil; but the search was likely to prove extremely difficult, because all water and soil is full of innumerable different organisms, and it would have been no light task to ascertain which of all these are really responsible for the disease among men, especially since Zeri had shown how difficult it was to produce infection by means of water in bulk.

At the same time, however, the hypothesis originally but vaguely mooted by Varro and Columella had been gaining ground. Indeed, Lancisi had repeated the same speculation in 1717, and seems actually to have suspected mosquitoes and to have studied them. So late as 1881 several theorists repeated this conception, though on studying their statements I think that little value is to be attached to them. In 1883, however, Dr. A. F. A. King wrote a most able paper on the subject, in which he gives no fewer than nineteen reasons why mosquitoes are likely to carry malaria. He thought that the insects bring the poison from the marsh and inoculate it into men. Many of his reasons are good, but others are now seen to have been untenable—and, in any case, he gave no experimental evidence. Next year, Laveran himself and Robert Koch independently enunciated the same speculation, but gave few reasons and no experiments in support of it. Ten years later, however, Manson repeated the hypothesis, but in a different form. He depended less upon the epidemiological evidence cited by King than upon certain parasitological evidence which occurred to himself. By this time (1894) the parasites of malaria had been very carefully studied, and were shown to possess, not only certain forms which provide for their propagation in the human host, but also other forms which, when the blood is freshly drawn, emit several so-called flagellated bodies. These latter forms had really led Laveran to his discovery, but their zoological significance still remained quite unexplained, and while some writers thought that they had some special significance, others believed them to be merely the result of death *in vitro*. Manson now urged that the flagellated bodies given off from these forms are really flagellated spores; that when mosquitoes ingest blood containing these forms, the flagellated spores escape in the insect and enter its tissues, where they ripen into some further unknown stage. Then, he thought, the insect dies two or three days later on the surface of the water, and this later stage of the parasites enters the water, and finally rises in the marsh mist to infect man. Obviously therefore Manson's hypothesis was quite different from King's; the former thought that mosquitoes derived the parasite from men and transferred it to the marsh, while King though just the opposite. Neither really reached the wonderful truth: both were half right, both half wrong. One cited parasitological and the other epidemiological evidence; and neither attempted experimental verifications.

Nevertheless, all these hypotheses, including those of the telluric miasma, were necessary for the laborious experimental inquiry which was now evidently demanded in the supreme interests of human life and health. I gather from what I have been told that my own work on the subject may prove sufficiently interesting to students to be worthy of mention here. I was first drawn to the malaria problem in the year 1889, when I observed during active service in Burma that the prevalence of malaria did not at all accord with the theory of the telluric and marsh miasma; and my doubts were strengthened during subsequent years by careful thought and study. If the poison is given off in an aerial form either from water or from soil, the disease ought to be almost uniformly distributed. Such, however, is not the case, and it really occurs principally in very small spots or pockets, generally in close proximity to stagnant water. Thus in one station where I afterwards served, my regiment was severely inflicted, while other regiments, scarcely a mile distant, remained almost entirely free. I was therefore very dissatisfied with this hypothesis, and being acutely alive to the great importance of the problem, I determined to study it carefully. In 1894 Manson acquainted me with his hypothesis, and I then

remembered that Laveran had said the same thing; but I was not aware of King's paper, or of the remarkable researches on Piroplasma by Smith and Kilborne.

In 1895 I attacked the work experimentally at Secunderabad in India, and determined first to adopt the mosquito speculation as a working hypothesis, and then to study other hypotheses if it failed—though I was much impressed by the former. The whole history of my work has been fully given in my Nobel Lecture, published in England by the Journal of the Royal Army Medical Corps (1905); and I need mention here only the salient points. For more than two years I caused mosquitoes of the genera Culex and Stegomyia to feed on patients containing malaria "crescents," which were the proper forms for transmission according to Manson. But my failure was complete, and indeed it was impossible to follow what he thought were flagellated spores in the insect's tissues.

I then adopted another technique, which was to compare insects of the same species which had been fed on malarial blood with those which had not been so fed, and to see if I could find any particular parasites in the former after they had been kept alive for some days. Many hundreds of insects were studied completely in this manner, and more than a thousand incompletely; but my failure was still complete. I obtained, however, a close practical experience of the insect's tissues, and learnt much about some common parasites which they possess. I also endeavoured to infect healthy persons by means of water in which presumably infected mosquitoes had been allowed to die, as Manson thought that such water would infect; and, lastly, I worked at a hypothesis of mine, that infected mosquitoes might carry infection by their bites, and Mr. Appia, assistant-surgeon of my hospital at Bangalore, kindly submitted to be bitten by many such insects in 1896. The result still remained quite negative. We now know the reason: the species of insect with which I was working were the wrong species. In 1907, however, I observed another variety, which I called dappled-winged mosquitoes, and which everyone now knows were Anophelines. I first saw these in an intensely malarious quarter near Ootacamund, where I myself acquired malaria during my investigations. A few months later I obtained eight of these insects in Secunderabad, and employed them for my usual experiments. Six of them died or gave bad dissections.

On August 20, 1897, I was so fortunate as to find in the tissues of one of these insects, four days after it had been fed upon a case of malaria, certain bodies which I had never observed in mosquitoes before. These contained the characteristic pigment of the malaria parasite. Next day, August 21, I found the same bodies in the last mosquito of my batch of eight—only they were now larger and more definite. To those who had not worked at the subject, such evidence might appear slight indeed; to me, after years of toil and thought, the evidence was immensely strong. A little later I found the same bodies in two more mosquitoes, and knew that I was on the right track; I felt that the two unknown quantities of this complex equation had been simultaneously found—the species of mosquito which carries malaria, and the position which the parasites take in its tissues, namely, the wall of the intestine.

Now, after seventeen years, I may perhaps be allowed to mention this point in order to encourage those students who, as I was then, are toiling after the unknown. But I at least obtained success, not only by labour but also by supreme good fortune; and I believe that but for this good fortune on these dates, we should still have remained ignorant of the manner in which malaria is conveyed, and might have remained ignorant of it for the next century. Unfortunately my work was now interrupted for nearly six months, just at a point when I expected to unravel the whole history of the malaria parasites in a few weeks; and it was not until March of next year that I was able to take up the thread again in Calcutta. For many reasons I was then unable to work at the human parasites, but commenced the study of the malaria parasites of birds, which are closely similar to the former. In a very short time I was able to demonstrate the presence in mosquitoes of pigmented bodies derived from the allied parasites. These bodies were found to grow regularly during one week after the insects had been fed, to reach maturity, and to produce a number of elongated spores. Now came an intensely exciting moment. What happens to these spores? According to Manson's hypothesis, they ought to liberate themselves in the water in which the insects died; but I had now shown that the insects did not die after two or three days, as he supposed, but may live for weeks. I attempted to follow the spores in all directions through the insect's tissues, into the lower intestine, and even into the egg. On July 4, 1898, however, I observed the fact that the spores enter the insect's salivary or poison glands.

The full truth was now immediately disclosed, and proved to be far more wonderful than any of us had ever dreamed of. The parasites are not only taken from man by the mosquitoes, as Manson had supposed, and are not only put into man by the mosquitoes, as King had supposed, but both hypotheses are true, and the insect carries the parasites directly from man to man. Here then was merely another case of the great law of metaxeny, which, however, was now proved for the first time to hold good for protozoal parasites. The malaria, like many larger parasites, require two hosts for their life-cycle.

These researches mapped out step by step every detail of the transformation, and gave us a much greater logical certainty than could be obtained by isolated infection experiments. Nevertheless, such experiments were attempted immediately, and in July and August I infected twenty-two out of twenty-eight healthy birds by the means of the bites of infected Culex—thus completing the whole story in detail. True, that was done with birds' malaria, and I had only seen the first steps of the process with regard to human malaria; but, any zoologist will know that with such closely allied species, the life-cycle of one is sure to be almost exactly similar to the life-history of the other—as proved to be the case here. My work was now interrupted again, and for nearly a whole year; and it was not until August, 1899, that I was able to show directly that the human parasites have exactly the same development. Meantime, however, Koch and Daniels had confirmed my work on birds' malaria; and certain Italian workers repeated it with regard to the human parasites, even to causing infection in healthy human beings (November, 1898), three months after my similar work with birds.

A very important discovery had been meantime made quite independently by MacCallum and Opie in America (1897), who showed that the bodies which Manson had thought were flagellated spores, were really sperms. Thus the large pigmented cells which I had found in mosquitoes at the same date were really fertilised macrogametes. This gave a much more correct zoological interpretation to my phenomena; but did not otherwise disturb the history which I had ascertained.

This then was the result obtained. Let me summarise it briefly. From the time of the Romans, we were aware that the malarial fevers are connected

with marshes and stagnant water in warm countries. Later, when it was seen that the disease is not confined only to the proximity of marshes, the theorists conceived that there is a telluric poison which causes malaria, and is especially abundant in damp places. All this was a very general proposition; and in order to prevent the disease, it was necessary to undertake very extensive drainage. Now, however, the new knowledge obtained enabled us to particularise the exact route of infection. We believe no longer that the poison is spread uniformly in the air of warm countries, but know that it is always contained in the minute bodies of certain insects, and, more than that, in the still more minute salivary glands of those creatures. Here then, science had given us knowledge which could not fail to be of immense practical importance to the world.

The discovery of the full life-cycle of the parasites enables us, not only to exercise the route of infection, but to determine exactly which species of mosquitoes are concerned. My failures with numerous undetermined species of the genera Culex and Stegomyia had shown that these are probably innocuous as regards malaria; and my ultimate success with certain Anophelines had shown that these were inculpated, Since then, the work of many observers has proved that, out of about five hundred Culicidæ only about twenty species carry malaria, and that all these belong to the Anophelines. So that for the prevention of malaria we are not obliged to deal with mosquitoes in general, but only with particular species.

Still further, the knowledge so obtained enabled us to study exactly the habits of the culpable species. In fact, I necessarily began such studies during the whole of my researches. The genera Culex and Stegomyia breed most commonly in artificial collections of water round houses; but I saw as early as 1897 that the dappled-winged mosquitoes (Anophelines) breed principally in different sites; that is,chiefly in natural collections of water, such as marshes, puddles, streamlets, and the edges of lakes, ponds, and rivers. This had been known before in the case of certain species; but I now saw the great epidemiological and sanitary bearing of the phenomenon. The reason why malaria is connected with marshes was now fully established by quite independent work. Humanity had explained the fact by supposing that the poison of malaria itself rises from the marsh; it was now seen that it is not the poison itself that rises from the marsh but the carrier of the poison. The net result was the same, except that we now knew not only the source of the poison but the exact method of transference. After all, humanity had reached the truth by empirical observations made during thousands of years; but science, in confirming those observations, has brought them to a fine point of exact theory.

But these were by no means the only fruits obtained. To return to our military parallel, when a commanding position of the enemy is carried, victory extends to a large area round it. The principal function of men of science is not merely to observe, describe, and catalogue phenomena, but, above all, to solve difficult problems; and the solution of one such problem frequently gives us the solution of many more. Such has proved to be true also in this case; for so soon as we had solved the malaria problem we were able to apply the same theorem to a number of other diseases. As already stated, Manson had shown in 1879 that the embryos of *F. bancrofti* can live in certain species of Culex—but he had not shown how they pass back from these insects to man. Now, however, James and Low, working independently, showed that the embryos enter the insect's proboscis, thus suggesting that they return into the human circulation by a route similar to that which is used by the parasites of malaria, and this work has been well followed up by Bahr and many others.

Another discovery, concerned with one of the most important of human diseases, namely, yellow fever, was made by Reed, Carroll, Lazear, and Agramonte during the last days of last century. Without knowing the causative agent of that disease, they yet showed by direct experiments on human beings that the infection is carried directly from man to man by another species of mosquito, *Stegomyia fasciata*, or *calopus*. It had long been stated by epidemiologists that malaria differs from yellow fever in that the former is connected with damp and decaying vegetation and the latter with insanitary conditions round houses. The former hypothesis was verified by the observation that Anophelines breed in terrestrial waters, and the latter was now explained by the fact that Stegomyia breed in artificial collections of water round houses. A little later Graham gave strong evidence in favour of the theory that dengue fever is carried by a species of Culex.

Thus mosquitoes have now been incriminated as the carrying agents of no fewer than four important disease of man. But this is by no means all. I have mentioned that before my work Bruce incriminated *Glossina morsitans* as the carrying agent of nagana; and he and others now showed that the deadly sleeping sickness of Africa is carried by other tsetse-flies. Various Spirochætes, especially that of tick fever, have been shown to be conveyed by ticks. A peculiar type of comparatively mild fever of which the cause, like that of yellow fever, is still unknown, has been proved to be conveyed by sand-flies. Several diseases of animals have been proved to possess a similar history; and others, both of animals and men, are suspected to lie in the same category. Perhaps, however, the most important and dramatic result was that obtained in the case of plague—the most terrible of epidemic diseases, the wonder and the despair of humanity since the beginnings of history, the scourge which was so often attributed to the direct action of God. It is due really to the rat flea. And this discovery signals another advance, because plague is, as we all know, due, not to an animal, but a vegetable parasite; and we therefore see that bacteria also may adopt precise routes of entry. A similar case is that of Mediterranean fever, which is carried principally by the milk of infected goats; and leprosy (another supposed scourge of heaven) has been attributed to the bites of bed-bugs; while some are even beginning to think that measles is due to fleas.

Gentlemen, I have now completed my task. We have seen at least another instance of how strongly recent advances in science bear upon medicine—how they confirm facts previously guessed at, achieve victories formerly undreamed of, and establish great theorems which will be of value to humanity so long as civilisation exists. But they affect not only the theory and the treatment of disease, but, what is perhaps still more important, its prevention; and it is especially in this line that the new theorems affect us. A whole great epidemiological group of diseases has been separated out, the so-called insect-borne diseases, and they are perhaps on the whole the most important, at least in the tropics. But, more than that, these discoveries give us practical methods of prevention, which may be summed up in the two words—no vermin. We now have a great sanitary ideal put before us: so to manage our habitations, villages, towns, and cities that the vermin in them shall be reduced to the lowest possible figure. Scores of entomologists and medical men are now dealing exactly with the habits of these creatures and showing us how to effect the required object. It demands only intelli-

gence, energy, and organisation on the part of administrators. Unfortunately these qualities are not always forthcoming, and administration often lags years behind the dictates of science. Although fifteen years have now elapsed since many of the facts which I have described were discovered, I think that I may say after constant study of the subject, and with all due consideration, that mankind has hitherto not effected more than about one-tenth of the improvement of health which it might have effected already if it had put its heart into the business.

When I had completed my work in 1899 I had fondly dreamed that a few years would see the almost complete banishment of malaria from the principal towns and cities in the tropics; that those benign climates and those beautiful scenes would be almost rid at once of a scourge which has blighted them from time immemorial. In this I have been disappointed. True, much has been done in certain places, as in Panama, Ismailia, Italy, West Africa, and parts of India and the Malay States, and in some other spots; but much more might have been done had we remained fully alive to our opportunities—and our duties. It is not the fault of science that we do not fully utilise the gifts which she gives to us. None of us here will live to see the full fruition of those gifts in this particular case; but we have at least seen the beginning, and may believe that our children will reap the profit.

But it is ever thus with science. Her slaves are like labourers condemned to drive tunnels through mountains—working, perhaps for years, in darkness, and oppressed by the immense spissitudes of nature above them; but always encouraged by the hope that at any moment they may emerge into the sunlight and upon the vision of a new world. May I conclude, as appropriate to the subject of this address, with four lines which were written years ago by one who was then toiling at the researches here described and in the darkness of the most utter failure—at work, moreover, for which he had little liking or ambition. They may encourage others who are now in a like case. Writing generally of the sublime spirit of inquiry he said:—

> Thee most we honour, thee
> Great Science. Hold thy way.
> The end thou canst not see;
> *But in the end, the day.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

EDINBURGH.—The election of the lord rector in each of the four Scottish Universities is one of the great events in a student's life. As a rule the candidates are chosen on account of their political eminence, and the election runs on purely party lines. For ten days preceding the election proper the Conservatives and Liberals vie with one another in the issue of posters, pamphlets, and cartoons. They raid each other's temporary offices at all hours of night and day; and in Edinburgh University when the great day of the election comes and the votes are being recorded in the various class-rooms, there is a gigantic tussle in the quadrangle so as to gain and hold a certain position of vantage below the clock. A torchlight procession finishes the day's doings. Early in the summer the two parties among the Edinburgh students chose Sir John Simon and Sir Edward Carson as their candidates, and had affairs developed normally there would have been very lively times. The shadow of the war, however, stayed the coming strife, and with great wisdom the leaders of the Liberal and Unionist Associations agreed to invite as their lord rector an eminent man of no political party. Their choice fell on Lord Kitchener, himself an honorary graduate of Edinburgh University. A new lord rector is chosen every three years. He represents the students on the University Court, the governing body of the University, and when present presides at the meetings of the Court. This, however, is a comparatively rare occurrence. His one imperative duty is to address the students of the University once during his tenure of office. The addresses of Lord Kitchener and of President Poincaré, who, as announced last week, has been elected rector of the University of Glasgow, will be looked forward to with great interest.

SHEFFIELD.—The council of the University has made the following appointments:—Mr. Wilfrid Vickers (Manchester), to the post of junior lecturer in education and assistant-master of method; Mr. H. J. Davies, to the post of demonstrator in engineering; and Mr. F. Orme, to the post of demonstrator in non-ferrous metallurgy.

The council of the University, realising that under the present exigencies of trade, manufacturers will be more than ever faced with problems requiring scientific solution, has approved the formation of a University Scientific Advisory Committee to offer assistance, under conditions arranged to safeguard the interests of the consulting profession, to manufacturers carrying on processes within the Sheffield University area. From applications already received, there is undoubtedly a big field for work in front of the committee.

MR. WINSTON CHURCHILL has been unanimously adopted as candidate for the rectorship of the University of Aberdeen, and will be returned unopposed on November 7.

A COURSE of six lectures on chemistry, beginning on November 16, is to be given at the Royal Academy of Arts, by Prof. A. P. Laurie, professor of chemistry in the academy. The lectures will be given on Mondays, Wednesdays, and Fridays, at 4 p.m. The subject of the first lecture will be the present condition and the pigments and mediums used in painting the Royal Academy diploma pictures. Future lectures will deal with modern pigments, mediums, oils, varnishes, methods of wall painting, the theory of colour, and the chemistry of building materials.

THE "Professional Classes War Relief Council" has issued an appeal for funds. Representatives from the chief professional institutions with representatives of the principal societies organising relief have united to form the council, so that it is acquainted with the circumstances and needs of each profession. The intention is to assist by advice and indirect help rather than by monetary assistance. The council does not intend to interfere in any way with the work of the committees controlling the various benevolent funds, but it thinks that considerable advantages will flow from bringing into close touch the professional institutions and the societies organising relief. The council will also be able to organise special kinds of assistance which will cause those funds to go further and do more ultimate good than would be possible without co-operation. The main object will be to bridge over the temporary difficulty caused by the war and to pave the way to permanent profitable employment. Since there is no other organisation or general fund to meet this kind of distress, the need for such a fund is very great. The chief forms of assistance arranged are in matters of education, training, emigration, maternity aid, and temporary employment, all of which are to be worked under separate representative subcommittees of men and women whose capabilities fit them especially for dealing with their special departments. It is necessary to form a central fund to carry on the work, this fund being used to maintain the forms of assistance

proposed; to help those members of professions which have no benevolent funds; to provide assistance for the families of professional men who have given up all to enlist for the service of their country. All those who have this need at heart are invited to send donations to the treasurer, Professional Classes War Relief Council, 13 and 14, Prince's Gate, S.W. Cheques to be crossed Messrs. Coutts and Co.

SOCIETIES AND ACADEMIES.

LONDON.

Zoological Society, October 27.—Prof. E. A. Minchin, vice-president, in the chair.—E. **Heron-Allen** and A. **Earland**: Foraminifera of the Kerimba Archipelago, obtained by Dr. J. J. Simpson in the years 1907–8. The area is new so far as the Foraminifera are concerned, the only records in any way approximating to it being the species described by d'Orbigny in 1826, by Brady in 1876 and 1884, by Möbius in 1880, and by Egger in 1893, from material which was collected from adjacent areas to the east of Madagascar, and off Mauritius and the Seychelles. The material consisted of fine siftings from dredgings, and having but few molluscan fragments and stones the larger adherent forms are poorly represented, but 470 species and varieties have been identified, including two new genera, and twenty-eight new species and varieties. The general facies is strikingly similar to that characteristic of Australian, Torres Straits, and Malay gatherings. The problem of distribution thus raised is obscure, the intervening ocean being abyssal, while the species now recorded are all shallow-water types. Many of the specialised forms common to these widely separated areas do not apparently occur in similar dredgings from intervening coasts, such as the Red and Arabian Seas. No doubt the equatorial current, which traverses the Indian Ocean from E. to W. and impinges on the African coast in our area, is primarily responsible for this phenomenon.—T. H. **Withers**: A new Cirripede. The description was based on a number of disconnected valves from the Chalk of Surrey and a complete specimen from the Chalk of Hertfordshire. Except for three valves referred to a new species of *Scalpellum* (*sensu lato*), the whole of the material belongs to a remarkable new asymmetrical Cirripede which differs from Verruca in the more primitive structure of the valves, in the presence of two lower lateral valves on the rostro-carinal side, and in the absence of interlocking ribs. This species represents the ancestral type from which has arisen the recent group of asymmetrical sessile Cirripedes forming the family Verrucidæ, and in its structure clearly shows its origin from the symmetrical pedunculate Cirripedes of the family Pollicipedidæ. It presents further evidence that the sessile condition was arrived at independently on several different lines of descent during the evolution of the Cirripedia.—W. L. **Distant**: Report on the Rhynchota collected by the Wollaston Expedition in Dutch New Guinea.

Challenger Society, October 28.—Dr. S. F. Harmer in the chair.—Dr. E. J. **Allen**: The artificial culture of marine plankton diatoms. Experiments were described in which it was attempted to grow cultures of the diatom *Thalassiosira gravida* in a medium containing only pure chemical salts dissolved in doubly distilled water, the medium having a composition as nearly as possible that of natural sea-water, with the addition of Miquel's nutrient solutions. In such purely artificial solutions little growth took place, but if a small percentage, even less than 1 per cent., of natural sea-water were added, large and vigorous cultures were obtained. There are reasons for supposing that this is due to the presence in the natural sea-water of minute traces of an organic substance which acts as a growth-stimulant. Provided that the small percentage of natural sea-water be present, the amounts of the various salts constituting the artificial sea-water, as well as the total salinity of the mixture, can be varied within wide limits without much detriment to the cultures.

MANCHESTER.

Literary and Philosophical Society, October 6.—Mr. Francis Nicholson, president, in the chair.—R. L. **Taylor** and Prof. Haldane **Gee**: Some original pen-and-ink diagrams used by Dalton. The uncertainty in Dalton's mind as to the number of atoms present in water, ammonia, carbon dioxide, and other compounds is faithfully reflected in some of the diagrams, and his attempts to depict the constitution of these and more complex bodies are full of interest.

October 20.—Mr. Francis Nicholson, president, in the chair.—Prof. S. J. **Hickson**: Sea-pens from the Malay Archipelago.—Dr. J. Stuart **Thomson**: Sea-pens from the Cape of Good Hope. These Pennatulaceæ were dredged off the coast of South Africa by the Cape Government trawler *Pieter Faure* during the ten years 1898–1907. Numerous species of scientific interest were collected, amongst which was *Cephalodiscus gilchristi*, an invertebrate having affinities with vertebrates. The collection of South African sea-pens is interesting, not so much because of the discovery of new species as on account of the fact that variations in certain species have been found which link genera together. One fine phosphorescent form, *Anthoptilum grandiflorum*, grows four or five feet in height, and is of a brick-red colour. It occurs in abundance at certain localities, probably forming dense miniature forests on the sea floor. The marine fauna of South Africa may be described as cosmopolitan in character.

PARIS.

Academy of Sciences, October 19.—M. P. Appell in the chair.—Gaston **Darboux**: A proposition relating to linear differential equations of the second order with two independent variables.—Pierre **Duhem**: The hydrodynamical paradox of Dalembert.—Edouard **Heckel**: Male castration of the giant maize of Serbia.—Comàs **Solà**: Photographic observation of a comet. The comet was found by its record on a photographic plate exposed October 17. It is probably identical with the comet discovered by Lunt at the Cape of Good Hope on September 18.—Ernest **Lebon**: A new table of divisors.—Alfred **Angot**: The earthquake of October 3, 1914. From the seismograph installed at the Parc Saint-Maur Observatory the epicentre was calculated to be 2600 kilometres distant, in Asia Minor. The epicentre proved to be only 150 kilometres from the calculated spot.

BOOKS RECEIVED.

Horses in Warfare. By E. Bell and H. Baillie-Weaver. Pp. 14. (London: Animals' Friend Society.)

Annual Amount and Distribution of Rainfall in the Philippines. By Rev. M. S. Masó. Pp. 42. (Manila: Bureau of Printing.)

Index to United States Documents relating to Foreign Affairs, 1828–61. Part i., A–H. Pp. 793. (Washington, D.C.: Carnegie Institution.)

North American Anura: Life-Histories of the Anura of Ithaca, New York. By A. H. Wright. Pp. 98+plates xxi. (Washington, D.C.: Carnegie Institution.)

A Mountain Rain-Forest: a Contribution to the Physiological Plant Geography of Jamaica. Pp. 110. (Washington: Carnegie Institution.)

Farm Accounts. By C. S. Orwin. Pp. 209. (Cambridge University Press.) 3s. net.

Panama: The Canal, the Country, and the People. By A. Bullard (Albert Edwards). Revised edition. Pp. xiv+601. (London: Macmillan and Co., Ltd.) 8s. 6d. net.

South-Eastern Agricultural College, Wye. Third Report on the Cost of Food in the Production of Milk, in the Counties of Kent and Surrey. By C. H. Garrard. Pp. 82. (Wye: South-Eastern Agricultural College.)

Proceedings of the Cambridge Philosophical Society. Vol. xviii. Part 1. (Cambridge University Press.)

Journal of the College of Agriculture, Tohoku Imperial University, Sapporo, Japan. Vol. vi. Parts ii. and iii. (Sapporo.)

Bulletin of the Imperial Earthquake Investigation Committee. Vol. vi., No. iii. Vol. vii., No. i. Vol. viii., No. 1. (Tokyo.)

Pumping by Compressed Air. By E. M. Ivens. Pp. vi+244. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 12s. 6d. net.

Foundations. By Prof. M. A. Howe. Pp. vii+110. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5s. 6d. net.

Department of the Interior. U.S. Geological Survey. Mineral Resources of the United States. Calendar Year 1913. 21 Publications. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Water Supply Paper, 327, 345 E, 345 F. Bulletin 548, 550, 574, 579, 581 B. (Washington: Government Printing Office.)

Department of the Interior. U.S. Geological Survey. Professional Paper 83. The Middle Triassic Marine Invertebrate Faunas of North America. By J. P. Smith. Pp. 254+plates xcix. (Washington: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. lxii. No. 3. Hodgkins Fund: Report on European Aeronautical Laboratories. By Dr. A. F. Zahm. (Washington: Smithsonian Institution.)

U.S. Department of Agriculture. Bureau of Biological Survey: North American Fauna. No. 36. (Washington: Government Printing Office.)

Proceedings of the American Philosophical Society. Vol. liii. Nos. 213, 214. (Philadelphia: Philosophical Society.)

Leland Stanford Junior University Publications. The Birds of the Latin Poets. By Prof. E. W. Martin. Pp. 260. Acceleration of Development in Fossil Cephalopoda. By Prof. J. P. Smith. Pp. 30+xv plates. A Morphological Study of Some Members of the Genus Pallavicinia. By Prof. D. H. Campbell and F. Williams. Pp. 44. (California: Stanford University.)

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 5.

ROYAL SOCIETY, at 4.30.—Acquired Radio-Activity: Sir William Crookes. Luminous Vapours Distilled from the Arc, with Applications to the Study of Spectrum Series and their Origin, II.: Hon. R. J. Strutt.—The Production of Neon and Helium by the Electrical Discharge: Prof. J. N. Collie, H. S. Patterson, and I. Masson.—The Flow of Viscous Fluids through Smooth Circular Pipes: Prof. C. H. Lees.—Quantitative Measurements of the Absorption of Light. I.: The Molecular Extinctions of the Saturated Aliphatic Ketones: F. O. Rice.—The Ignition of Gases by Condenser Discharge Sparks: Prof. W. M. Thornton.—The Spark Spectrum of Nickel under Moderate Pressures: E. G. Bilham.

CHILD STUDY SOCIETY, at 7.30.—Classification of the Deaf Child for Educational Purposes: P. M. Yearsley.

MONDAY, NOVEMBER 9.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of the War: Hilaire Belloc.

TUESDAY, NOVEMBER 10.

ZOOLOGICAL SOCIETY, at 5.30.—Exhibition of Photographs Illustrating the Life-history of the Gannet: L. Balfour.—Lantern Exhibition showing the Differences between the Pine and Beech Martens: R. I. Pocock.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. XV.: A New Genus and Species of the Family Acoleidæ: Dr. F. E. Beddard.—Report on the Spiders Collected by the British Ornithologists' Union Expedition and the Wollaston Expedition to Dutch New Guinea: H. R. Hogg.

MINERALOGICAL SOCIETY, at 5.30.—Albite; Its Crystal Elements, etc.: Prof. W. J. Lewis.—The Determination of the Maximum Extinction, etc., of Monoclinic Pyroxenes in Thin Sections: H. Collingridge.—Note on Calcite from the Chalk at Corfe Castle, Dorset: Prof. H. L. Bowman.—Barkevicite from Lugar, Ayrshire; and Litharge from Persia: A. Scott.—Meteoric Irons of Uwet and Angela; the Identity of Angela with La Primitiva: Dr. G. T. Prior.

THURSDAY, NOVEMBER 12.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Analyses of Agricultural Yield. I.: Spacing Experiments with Egyptian Cotton: W. L. Balls and F. S. Holton.—The Fixation of Arsenic by the Brain after Intravenous Injections of Salvarsan: J. McIntosh and P. Fildes.—The Production of Anthocyanins and Anthocyanidins. II.: A. E. Everest.—Living Observations on the Life-Cycle of a New *Flagellate-Helkesimastix Faecicola*, together with Remarks on the Question of Syngamy in the Trypanosomes: H. M. Woodcock and G. Lapage.—The Antagonistic Action of Carbon Dioxide and Adrenalin on the Heart: S. W. Patterson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Cables: C. J. Beaver.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting. Presidential Address: Mathematical Research; Prof. Love.

FRIDAY, NOVEMBER 13.

ALCHEMICAL SOCIETY, at 8.15.—The Movement of Alchemical Research in France: Actual Traces of Transmutation: W. de Kerlor.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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